

C O N T R A C T

THIS AGREEMENT, made and concluded this day of 1/20/2022, by and between the **CITY OF READING**, a municipal corporation of the Commonwealth of Pennsylvania, located in the County of Berks, said Commonwealth, party of the first part, and **BRENDAN STANTON, INC., DBA BSI ELECTRICAL CONTRACTORS**, Contractor, party of the second part, pursuant to law and to the provisions and requirements of the ordinance of the City of Reading, Pennsylvania.

WITNESSETH, that the parties to these presents, each in consideration of the agreements on the part of the other herein contained, have agreed, and hereby do agree, the party of the first part for itself, its successors and assign, and the party of the second part for itself, himself, or themselves, its successors, or his or their executors and administrators as follows:

CONTRACTOR'S GENERAL AGREEMENT. The Contractor covenant, promises and agrees to and with the party of the first part, for the consideration hereinafter mentioned and contained, and under the penalty expressed in a bond and hereto attached, to furnish all the material, machinery, equipment, tools, labor and transportation, except as hereinafter otherwise provided, at his own cost, necessary or proper for the purpose of executing the work embraced in this contract in a good, substantial and workmanlike manner, and in strict accordance with the specifications pertaining to this contract a herein contained.

PARTS OF CONTRACT. The Location Map; Notice to Contractors; Bid Instructions; Documents to be Submitted with Bid; Contract Documents; Documents to be Submitted During the Course of the Contract; Wage Rate Determinations; Notice of Preconstruction Requirements and Pre-Construction Conference Questionnaire; Affirmative Action Requirements; General Provisions; Supplementary General Terms and Conditions; Technical Specifications; Supplementary Technical Specifications; and Correspondence and Supportive Documentation shall each form a part of the Contract.

THE CONTRACT SUM. The City shall pay the Contractor for the performance of the Contract, subject to additions and deductions provided therein, in current funds as follows:

FIVE HUNDRED FIFTY TWO THOUSAND SEVEN HUNDRED AND FIFTY DOLLARS (\$552,750.00).

For Reading Public Library Electrical and Mechanical Upgrades.

Where the quantities originally contemplated are so changed that application of the agreed unit price to the quantity of work performed is shown to create a hardship to the Owner or the Contractor, there shall be an equitable adjustment of the Contract to prevent such hardship.

TIME & MANNER OF DOING WORK. The party of the second part agrees to commence the construction of the work to be done under this contract, immediately upon receiving written notice from the Director of Public Works, or other applicable Director, so to do and to complete the entire work as specified in the technical specifications, it being expressly agreed and

understood that the time of beginning, rates of progress and time of completion of the work are essential under this contract. Time is to be considered to be the essence of this contract.


STIPULATED DAMAGES. The Contractor shall begin work within ten (10) days of receipt of written notice from the applicable Director, to do so. If the Contractor fails to complete and finish the work in conformity with the terms and provisions of this Contract within the time hereinbefore specified, he shall pay to the City the sum of Five Hundred Dollars (\$500.00) for each and every day thereafter, including Sundays and holidays, that the finishing of the Contract is delayed, which sum shall be construed as stipulated and liquidated damages and not as a penalty and shall be deducted from the amount due by the terms of the Contract; provided, however, that in case of justifiable delay, the City shall extend the time for completion of said work as provided for in Article G.7, but no extension of time for any reason beyond the time fixed herein for the completion of the work shall be deemed a waiver by the City of the right to abrogate this Contract for abandonment for delay.

LIENS. Neither the final payment nor any part of the retained percentage shall become due until the Contractor, if required, shall deliver to the City a complete release of all liens arising out of this Contract, or receipts in full in lien thereof, and, if required in either case, an affidavit that so far as he has knowledge or information the release and receipts include all the labor and material for which a lien could be filed. If any lien remains unsatisfied after all payments are made, the Contractor shall refund to the City all monies that the latter may be compelled to pay in discharging such a lien, including all costs and a reasonable attorney's fee.


IN WITNESS WHEREOF, the said City of Reading has caused this Agreement to be executed by its Mayor, and its corporate seal to be hereunto affixed, duly attested by its City Clerk, and the Vendor has caused this Agreement to be executed by its President and its corporate seal to be hereunto affixed, duly attested by its Secretary, has hereunto set his/their hand(s) and seal(s) the day and year first above written.

Signed and sealed in the Presence of:

Attest:

DocuSigned by:

 73DE031C240D451
 City Clerk


CITY OF READING

DocuSigned by:

 9DBC20E27C594BB...
 Mayor Eddie Moran

DocuSigned by:

 AC87F2C12F7C459
 By: _____
 Melissa Reynolds

BRENDAN STANTON, INC., DBA BSI
 ELECTRICAL CONTRACTORS,

DocuSigned by:

 DE83C172908E4D6...
 By: _____
 Brendan Stanton

Title: Contract Coordinator

Title: President/Secretary

ADDENDUM

Project Manual

Department of Public Works

City of Reading, Pennsylvania

**Reading Public Library
Electrical and Mechanical Upgrades**



Prepared by:

Buchart Horn Architects
445 West Philadelphia Street
York, PA 17401

Released for Bidding
October 4, 2021

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NOTICE AND INSTRUCTIONS

CITY OF READING, PENNSYLVANIA

NOTICE TO CONTRACTORS

The City of Reading will receive proposals for the Reading Public Library Electrical and Mechanical Upgrades Project submitted electronically via the PennBid Program (<https://pennbid.procureware.com>). Proposals shall be received until 3:00 p.m., prevailing time on November 10, 2021.

Proposals received via PennBid after the hour specified will not be considered.

A mandatory pre-bid conference will be held at 10:00 a.m. local time on October 12, 2021 at the project site, 100 South 5th Street, Reading, PA 19602.

Specifications and bid forms, upon which all bids must be submitted, can be obtained via Penn Bid at <https://pennbid.procureware.com>.

Each proposal shall be accompanied by bid surety in the amount of ten percent (10%) of the proposal. A certified check or bid bond will be accepted.

Attention is called to the fact that prevailing minimum wage rates are a provision of this contract. Employees shall not be discriminated against because of race, color, age religion, sex or national origin.

The City of Reading reserves the right to accept or reject any or all bids, and to accept or reject any part of a bid that may not be in the public interest.

Tammi Reinhart
Purchasing Coordinator

INSTRUCTIONS TO BIDDERS

PROPOSAL SUBMISSION

Proposals shall be submitted via the PennBid Program (<https://pennbid.procureware.com>). This shall be submitted on or before the time stated in the NOTICE TO CONTRACTORS.

Proposals received via PennBid after the hour specified will not be considered.

BONDS

Bid security, in the amount of ten percent (10%) of the bid price shall accompany each proposal. This bid security may be a Certified or Cashier's Check, or a bid bond furnished by a surety company, satisfactory to the City of Reading. The Contractor shall furnish a performance bond in an amount equal to one hundred percent (100%) of the Contract Sum as security for the faithful performance of this Contract and also a labor and material payment bond in an amount not Less than one hundred percent (100%) of the Contract Sum as security for the payment of persons performing labor on the Project under this Contract and furnishing materials in connection with this Contract. The successful bidder, upon award of contract, shall furnish at the time of execution of the same, a Maintenance Bond by a surety company acceptable to the City of Reading, in an amount equal to one hundred percent (100%) of the contract, to guarantee satisfactory performance. All bonds are subject to approval by the City Solicitor.

Upon the request of any person or entity appearing to be a potential beneficiary of bonds covering payment of obligations arising under the Contract, the Contractor shall promptly furnish a copy of the bonds or shall permit a copy to be made.

The bonds shall be executed on the forms provided in the Bid Documents. The bonds shall be executed by a corporate surety licensed and qualified to do business in the Commonwealth of Pennsylvania. The surety company shall be named in the current list of companies holding certificates of authority as accepted sureties on federal bonds and as acceptable re-insuring companies as published in Circular 570 (as amended) by the audit staff, Bureau of Government Financial Operations, U.S. Treasury Department, and the amount of the bonds shall not exceed the underwriting risk of such surety as set forth in said Circular or revision thereof. The bonds shall be accompanied by a current and certified power of attorney evidencing the authority of the agent of the surety to execute the bonds as of the date of the bonds.

In case the contract is awarded to a bidder who fails to enter the contract or to deliver all required bonds and affidavits, the cash or check deposited shall become absolute property of the City; or if a bond has been deposited, it shall become payable immediately. Cash, checks or bonds deposited will be returned to unsuccessful bidders as soon as the contract is awarded, or all bids rejected.

INSURANCE

The Contractor, at the time of execution of the contract, shall also furnish the City with insurance certificates of adequate limits, as later indicated, to protect the City of Reading, its agents, and employees from any litigation involving Workers' Compensation, Public Liability and Property Damage, involved in the work. All subcontractors must also furnish copies of their liability insurance and Workers' Compensation Insurance certificates to the City. The City will allow no subcontractor to perform any work under this contract unless such certificates are submitted to and approved by the City beforehand.

CONTRACTOR'S LIABILITY INSURANCE

The status of the Contractor in the work to be performed by the Contractor is that of any independent Contractor and as such, he shall properly safeguard against any and all injury or damage to the public, to public and private property, materials and things, and as such he alone shall be responsible for any and all damage, loss or injury to persons or property that may arise, or be incurred, in or during the conduct or progress of said work without regard to whether or not the Contractor, his sub-contractors, agents, or employees have been negligent, and the Contractor shall keep the City free and discharged of and from any and all responsibility and liability therefore of any sort or kind. The Contractor shall assume all responsibility for risks or casualties of every description, for any or all damage, loss or injury to persons or property arising out of the nature of the work from the action of the elements, or from any unforeseen or unusual difficulty. The Contractor shall assume and be liable for all blame and loss of whatsoever nature by reason of neglect or violation of any Federal, State, County or Local laws, regulations, or ordinances; the Contractor shall indemnify and save harmless the City from all suits or actions of law of any kind whatsoever in connection with this work and shall if required by the City, produce evidence of settlement of any such action before final payment shall be made by the City. Contractor's Liability Insurance Certificate shall include the save harmless clause and shall be filed with the City.

The Contractor shall maintain such insurance as will protect him from claims under worker's compensation acts and from claims for damages because of bodily injury, including death, and property damage, which may arise from and during operations under this Contract, whether such operations be by himself, by any subcontractor or anyone directly or indirectly employed by either of them. Contractor's liability insurance shall be in the names of the Contractor and the City, as their respective interests may appear. Certificates of such insurance shall be filed with the City Risk and Safety Manager.

The minimum amount of liability insurance to be maintained by the Contractor during the life of the contract shall be as follows:

Comprehensive General Liability – for bodily injury and property damage – including any liability normally covered by a general liability policy with limits of not less than \$1,000,000 per occurrence and \$2,000,000 in the annual aggregate.

Business Automobile Liability – For owned, non-owned, leased and hired vehicles with a combined single limit of not less than \$1,000,000 for bodily injury and property damage.

Worker's Compensation – Statutory limits in each state in which Service Provider is required to provide Worker's Compensation coverage including "All States" and "Voluntary Compensation" endorsement, and a Waiver of Subrogation endorsement in favor of the County.

Prior to commencement of performance of this Agreement, Contractor shall furnish to the City a certificate of insurance evidencing all required coverage in at least the limits required herein, **naming the City of Reading, its elected officials, agents, and employees as additional insureds under the Comprehensive General Liability coverage**, and providing that no policies may be modified or cancelled without thirty (30) days advance written notice to the City. Such certificate shall be issued to Pennbid (<https://pennbid.procureware.com>). All policies shall be in effect with companies holding an A.M. Best rating of "A-" or better and shall be licensed to do business in the Commonwealth of Pennsylvania. Such companies shall also be acceptable to the City.

Please forward a certificate of insurance verifying these insurance requirements.

Liability insurance shall include automobile coverage, including "hired automobiles and non-ownership automobiles."

Liability insurance shall include the hazard of collapse, damage to underground utilities, underground blasting, and excavation. Prior to any blasting which may be required, blasting insurance shall be obtained by the Contractor in an amount satisfactory to the City Engineer.

Liability insurance shall include the hazard of building collapse and of damage to adjoining properties and/or to individuals located within or adjacent to each project site.

All subcontractors performing work under this contract must furnish to the City a copy of their Certificate of Insurance for Workers' Compensation and liability for bodily injury and property damage.

WAGES AND EMPLOYMENT REQUIREMENTS - N/A

EQUAL EMPLOYMENT OPPORTUNITY

During the performance of this Contract, the Contractor agrees as follows:

The Contractor will not discriminate against any employees or applicant for employment because of race, color, religion, sex, or national origin. The Contractor will take affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to race, color, religion, sex, or national origin. Such action shall include, but not be limited to, the following: employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The Contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices that may be provided by the City setting forth the provisions of this nondiscrimination clause.

The Contractor will, in all solicitations or advertisements for employees placed by or on behalf of the Contractor, state that all qualified applicants will receive consideration for employment without regard to race, color, religion, sex, or national origin.

The Contractor will send to each labor union or representative of workers with which the Contractor has a collective bargaining agreement or other contract or understanding, a notice advising the labor union or workers' representatives of the Contractor, commitments under this Section and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

In the event of the Contractor's noncompliance with the non-discrimination clauses of this Contract or with any of the said rules, regulations, or orders, this Contract may be cancelled, terminated, or suspended in whole or in part and the Contractor may be declared ineligible for further City contracts.

The Contractor will include the provisions of these paragraphs in every subcontract or purchase order unless exempted.

EMPLOYMENT OF CERTAIN PERSONS PROHIBITED

No person who, at the time, is serving sentence in a penal or correctional institution shall be employed on the work covered by this Contract.

SUPERVISION OF WORKERS

The Contractor shall provide qualified supervision of each crew at all times while working under this contract. Each supervisor shall be authorized by the Contractor to accept and act upon all directives issued by the City. Failure for the supervisor to act on said directives shall be sufficient cause to give notice that the Contractor is in default of the contract unless such directives would create potential personal injury or safety hazards.

This contract will be under the direct supervision of the City or its authorized representatives. Any alterations or modifications of the work performed under this contract shall be made only by written agreement between the Contractor and the City authorized representatives and shall be made prior to commencement of the altered or modified work. No claims for extra work or materials shall be allowed unless covered by written agreement.

SUBCONTRACTS

The Contractor will not be allowed to subcontract work under this contract unless the City grants written approval. The Subcontractor, as approved, shall be bound by the conditions of the contract between the City and the Contractor. The authorization of a Subcontractor is to perform in accordance with all terms of the contract and specifications. All required notices, work orders, directives, and requests for emergency services will be directed to the Contractor. All directions given to the Subcontractor in the field shall bind the Contractor as if the notice had been given directly to the Contractor.

QUALITY

Where the specification asks for a certain article or "Approved Equal" and the bidder intends to furnish an article which the bidder considers equal to the one named, the bidder must specify in the bid the name and grade of said article. All disputes concerning grade and quality of materials or work shall be determined by a person duly authorized by the Director of Public Works.

TIME OF COMPLETION

The bidders are herewith cautioned that they must complete all work within 270 calendar days from the date of the notice to proceed. To insure timely completion, the successful bidder will be required to furnish adequate equipment and qualified personnel in sufficient numbers at all times.

Where a date is set for delivery of materials or the performance of work, said materials must be delivered or work performed, in accordance with the specifications or description herein contained on or before said date, or the order to the delinquent party will be cancelled and awarded to the next lowest responsible bidder.

BUSINESS PRIVILEGE TAX

The City of Reading imposes a Business Privilege License, at \$55.00 per calendar year. In addition, a Business Privilege Tax is imposed at the rate of 2¼ mills upon the gross receipts attributable to business conducted within the City of Reading.

PERMITS/LICENSES

The Contractor shall, at his/her expense, pay all fees and procure all necessary licenses and permits needed to conduct the work required under the terms of this contract. The Contractor shall give any and all necessary formal notices required in conjunction with the lawful prosecution of the work of this contract.

BASIS OF PAYMENT

All prices to be quoted F.O.B. Reading, PA destination. The City of Reading is tax exempt.

OBSERVANCE OF LAWS, ORDINANCES AND REGULATIONS

The Contractor at all times during the term of this contract shall observe and abide by all Federal, State, and Local laws which in any way affect the conduct of the work and shall comply with all decrees and orders of courts of competent jurisdiction. The Contractor shall comply fully and completely with any and all applicable State and Federal statutes, rules and regulations as they relate to hiring, wages and any other applicable conditions of employment.

MANDATORY PRE-BID MEETING

A mandatory pre-bid meeting has been scheduled for October 12, 2021 at 10:00 a.m. at the project site, 100 South Fifth St., Reading, PA. A site inspection is part of the technical specification, and required prior to submitting a proposal. For the purpose of familiarizing Bidders with the project, answering questions, and issuing addenda as needed for clarification of the bidding document, all questions shall be submitted via the PennBid Program (<https://pennbid.procurement.com>).

QUESTIONS REGARDING SPECIFICATIONS ON PROPOSAL PROCESS

To ensure fair consideration for all proposers, the City prohibits communication to or with any department director, division manager or employee during the submission process with the exception of those questions relative to interpretation of specifications or the proposal process. No interpretations of the meaning of the Bid documents will be made to any bidder orally.

Every request for such interpretation shall be submitted via the “Questions” tab within PennBid to be given consideration must be sent in prior to 10:00 a.m. on October 21, 2021.

Any and all such interpretation will be in the form of an Addendum to the Contract Documents and will be issued via PennBid to all prospective proposers no later than November 1, 2021.

Additionally, the city prohibits communications initiated by a proposer to any City Official or employee evaluating or considering the proposals prior to the time an award decision has been made. Any communication between proposer and the City will be initiated by the appropriate City Official or employee in order to obtain information or clarification needed to develop a proper, accurate evaluation of the proposal. Such communications initiated by a proposer may be grounds for disqualifying the offending proposer from consideration for award of the proposal and/or any future proposal.

WITHDRAWAL OF PROPOSALS/BIDS

After a bid has been opened, it may not be withdrawn except as provided by Act of January 23, 1974, P.L. 9 No. 4 as same may be amended.

No bids may be withdrawn for a period of ninety (90) days following the formal opening and receipt of bids by the City of Reading.

BID REJECTION

The City of Reading reserves the right to reject any or all bids and to accept or reject any part of any bid. It also reserves the right to waive any technical defects or minor irregularities, which in its discretion, is determined to be in the best interest of the City.

EXECUTION OF CONTRACT

The successful Bidder shall, within ten (10) calendar days after mailing of contract documents by the City to the Principal, enter into contract with the City on form as included within the bidding documents for the appropriate bonds, indemnities and insurances required hereunder.

The contract, when executed, shall be deemed to include the entire agreement between the parties; the Contractor shall not base any claim for modification of the contract upon any prior representation or promise made by the representatives or the City, or other persons.

All attachments are considered as part of this document.

METHOD OF PAYMENT

Payments shall be based on an invoice submitted by the General Contractor or approved representative (Construction Manager). The City shall have the right to withhold disbursement funds if in the City's opinion the construction work for which payment has been requested is of poor workmanship, contrary to any applicable codes and contract specifications, is in violation of appropriate paperwork requirements that are not up to date and approved for this billing period, General Contractor fails to comply with this Agreement, or for other conditions or circumstances which the City deems not to be in the best interest of the public.

Ten percent (10%) of each General Contractor invoice request shall be retained by the City on this contract until it is completed up to City codes and contract specifications and approved by a City Official or person representing a City Official (Architect or Engineer).

ACCESS TO ACCOUNTING RECORDS

The contractor shall certify that all materials, equipment and labor charged to the City are accounted for and shall keep such full and detailed accounts as may be necessary for proper financial management under this Agreement. The City or its representative shall be afforded access to all the Contractor's records, books, correspondence, instructions, drawings, receipts, vouchers, memoranda, and similar data relating to this contract, and the Contractor shall preserve all such records for a period of three (3) years, or for such longer period as may be required by law, after the final payment.

ASSIGNMENT OF REFUND RIGHTS

The City is not subject to federal, state or local sales or use tax or federal excise tax. Contractor hereby assigns to City all of its rights, title, and interest in any sales or use tax which may be refunded as a result or the purchase of any materials purchased in connection with the contract and contractor, unless directed by City, shall not file a claim for any sales or use tax refund subject to this assignment. Contractor authorizes City, in its own name or the name of contractor, to file a claim for a refund of any sales or use tax subject to this assignment.

CONTRACTS WITH SUBCONTRACTORS

The Contractor agrees to include the above references paragraphs in any contracts with subcontractors.

NOTICE TO PROCEED

The Contractor shall begin work on the job site within ten (10) days after receiving Notice to Proceed from the City.

DISCONTINUANCE OF WORK

The Contractor upon receipt of either written or oral notice to discontinue such practice shall immediately

discontinue any practice obviously hazardous as determined by the City.

CONTRACT TERMINATION

The City shall have the right to terminate a contract or a part thereof before the work is completed in the event:

1. Previous unknown circumstances arise making it desirable in the public interest to void the contract.
2. The contractor is not adequately complying with the specifications.
3. The contractor refuses, neglects, or fails to supply properly trained or skilled supervisory personal and/or workers or proper equipment.
4. The contractor in the judgment of the City is unnecessarily or willfully delaying the performance and completion of the work.
5. The contractor refuses to proceed with work when and as directed by the City.
6. The contractor abandons the work.

Contractors who have questions concerning various aspects of this Contract should contact the following persons: Tammi Reinhart, Purchasing Coordinator at Tammi.Reinhart@readingpa.gov.

DOCUMENTS TO BE SUBMITTED WITH BID

PROPOSAL
FOR
READING PUBLIC LIBRARY
5TH AND FRANKLIN STREETS
ELECTRICAL AND MECHANICAL UPGRADES
CITY OF READING, PENNSYLVANIA

Proposal of

(name)

(address)

TO: Mayor Eddie Moran
City of Reading
815 Washington Street
Reading, PA 19601

Dear Mayor Moran:

In conformity with City Plans and specifications, all as prepared by the Public Works Department and after an examination of the site of the work, and the Contract Documents, including the instructions to Bidders, Form of Proposal, Bid Bond and Conditions, the undersigned submits this proposal, and encloses herewith as proposal guaranty, a Certified or Treasurer's Check, or Bid Bond, in an amount not less than ten percent (10%) of the bid herein submitted, which it is understood will be forfeited if this proposal is accepted by the City of Reading, and the undersigned fails to furnish approved bonds and execute the contract within the time stipulated; otherwise, the guarantee will be returned.

The undersigned declares that no Member of Council, Director of Department, Division Manager, deputy thereof or clerk therein, or other officer of the City of Reading, is directly or indirectly interested as principal, surety or otherwise in this proposal or has any supervision or overall responsibility for the implementation in administration of the contract.

It is certified that the undersigned is the only person(s) interested in this proposal as principal and that the proposal is made without collusion with any person, firm, or corporation.

It is hereby agreed to execute the contract and furnish surety company bonds, on the forms enclosed in the Contract Documents, in the amount of one hundred percent (100%) of the contract price within ten

(10) days of mailing of the contract documents from the City to the Principal, and to begin work within ten (10) days after receipt of Notice to Proceed from the City of Reading.

CONTRACT 1**BASIS OF BID – MECHANICAL UPGRADES****LUMP SUM BID**

Bidder will complete the Work in accordance with the Contract Documents for the following lump sum (stipulated) price:

Contingency: \$ _____

Lump Sum Bid Price: \$ _____

TOTAL BID PRICE \$ _____

RECEIPT OF ADDENDA

Bidder hereby acknowledges receipt of the following Addenda:

Addendum Number	Addendum Date

CONTRACT 2**BASIS OF BID – UPGRADES****LUMP SUM BID:**

Bidder will complete the Work in accordance with the Contract Documents for the following lump sum (stipulated) price:

Contingency: \$ _____
 Lump Sum Bid Price: \$ _____

TOTAL \$ _____

RECEIPT OF ADDENDA

Bidder hereby acknowledges receipt of the following Addenda:

Addendum Number	Addendum Date

IN WITNESS WHEREOF, this proposal has been executed this ____ day of _____, 20 __, by the setting hereunto of his or its hand and seal.

FOR INDIVIDUAL:

_____(Seal)

FOR CORPORATION:

(Name of Corporation)

By:

Attest:

(Official Title)

(Secretary)

FOR PARTNERSHIP:

(Name of Partnership)

By:

_____(Seal)

_____(Seal)

Partners

FORM OF BID BOND

BOND

KNOW ALL MEN BY THESE PRESENTS that we, the undersigned, _____
 _____, as Principal (the "Principal"), and _____
 _____ a corporation organized and existing under laws
 of the _____ of _____, as Surety (the "Surety"), are held and firmly bound
 unto _____ as Oblige (the "Oblige"), as hereinafter set
 forth, in the full and just sum of _____ Dollars (\$_____), lawful money of the
 United States of America, for the payment of which sum we bind ourselves, our heirs, administrators,
 executors, successors and assigns, jointly and severally, firmly by these presents.

WITNESSETH THAT:

WHEREAS, the Principal herewith is submitting a Proposal to the Oblige to perform the Work
 in connection with the construction of _____

 pursuant to plans, specifications and other documents constituting the Contract Documents which are
 incorporated into said Proposal by reference (the "Contract Documents"), as prepared by the Department
 of Public Works, City Hall, 815 Washington Streets, Reading, PA 19601.

WHEREAS, it is a condition of the receipt and consideration by the Oblige of said Proposal that
 it shall be accompanied by proposal guaranty to be held by the Oblige on terms hereinafter set forth.

NOW, THEREFORE, the condition of this Bond shall be such that, if the Principal, within ten (10)
 days after mailing of contract document by the City to Principal, shall furnish to the Oblige a Performance
 Bond, Payment Bond and a Wage Rate Compliance Bond, and upon award of a contract to him by the
 Oblige, shall execute and deliver the Agreement and furnish to the Oblige proper evidence of
 effectiveness of insurance coverage, respectively within the time, in the forms and in the amounts, as
 appropriate, required by the Contract Documents, then this Bond shall be void, otherwise, this Bond shall
 remain in full force and effect.

The Principal and the Surety agree to pay to the Obligees the difference between the amount of said Proposal, as accepted by the Obligees, and any higher amount for which the required work shall be contracted for by the Obligees, together with any additional advertising costs, architect's fees, legal fees and any all other fees and expenses incurred by the Obligees by reason of the failure of the Principal to enter into such Agreement with the obligee, or to furnish such Contract Bonds, or to furnish evidence of effectiveness of such insurance coverage; provided, however, that (1) the obligation of the Surety shall not exceed the stated principal amount of this Bond; and (2) if the Obligees should not procure an executed contract with any other person for the performance of the work contemplated in said Proposal, as accepted by the Obligees, upon the same terms and conditions, other than price, as provided in the Contract Documents, within the period provided in the Contract Documents during which no proposals of bidders may be withdrawn, whether because of the lack of other proposals, or because of the inability or refusal of any other bidder to enter into an appropriate contract, or because the cost under any higher proposal would be greater than the Obligees shall determine, in its sole discretion, that it can afford, then the Principal and the Surety agree to pay to the Obligees the full amount of this Bond as liquidated damages.

IN WITNESS WHEREOF, the Principal and the Surety cause this Bond to be signed, sealed and delivered this _____ day of _____, 20__.

(INDIVIDUAL PRINCIPAL)

_____(Seal)
(Signature of Individual)

Witness:

Trading and Doing Business as:

(PARTNERSHIP PRINCIPAL)

_____(Seal)
(Name of Partnership)

Witness:

By: _____(Seal)
(Partner)

Witness:

By: _____(Seal)
(Partner)

Witness:

By: _____(Seal)
(Partner)

Witness:

By: _____(Seal)
(Partner)

(CORPORATION PRINCIPAL)

Attest:

(Secretary)

(Name of Corporation)

By: _____
(President/Vice President)

(CORPORATE SEAL)

or (if appropriate)

(Name of Corporation)

By: _____
Authorized Representative

*Attach appropriate proof, dated as of the same date as the Bond, evidencing authority to execute in behalf of the corporation.

Signed _____

(Title)

Subscribed and sworn to before me on

this ____ day of _____, 20 ____

(Title)

My commission expires:

(CORPORATION SURETY)

(Name of Corporation)

By: _____
** (Attorney-in-fact)

Witness:

(Corporate Seal)

** Attach an appropriate power of attorney, valid and in effect as of the date of this affidavit, evidencing the authority of the Attorney-In-Fact to act in behalf of the corporation.

NON-COLLUSION AFFIDAVIT

INSTRUCTIONS FOR NON-COLLUSION AFFIDAVIT

This Non-Collusion Affidavit is material to any contract pursuant to this bid. According to the Pennsylvania Antibid-Rigging Act, 73 P.S. 1611 et seq., governmental agencies may require Non-Collusion Affidavits to be submitted together with bids.

This Non-Collusion affidavit must be executed by the member, officer, or employee of the bidder who is authorized to legally bind the bidder.

Bid rigging and other efforts to restrain competition, and the making of false sworn statements in connection with the submission of bids are unlawful and may be subject to criminal prosecution. The person who signs the Affidavit should examine it carefully before signing and assure himself or herself that each statement is true and accurate, making diligent inquiry, as necessary, of all other persons employed by or associated with the bidder with responsibilities for the preparation, approval, or submission of the bid.

In the case of a bid submitted by a joint venture, each party to the venture must be identified in the bid documents, and an Affidavit must be submitted separately on behalf of each party.

The term "complementary bid" as used in the Affidavit has the meaning commonly associated with that term in the bidding process, and includes the knowing submission of bids higher than the bid of another firm, any intentionally high or noncompetitive bid, and any form of bid submitted for the purpose of giving a false appearance of competition.

Failure to file an Affidavit in compliance with these instructions will result in disqualification of the bid.

NON-COLLUSION AFFIDAVIT OF PRIME BIDDER

State of _____

County of _____

_____, being first duly sworn, deposes and says that:

He/She is _____

(Owner, Partner, Officer, Representative or Agent)

of _____, the Bidder that has submitted the attached Bid or Bids;

He/She is fully informed respecting the preparation and contents of the attached Bid and of all pertinent circumstances respecting such Bid;

Such Bid is genuine and is not a collusive or sham Bid;

Neither the said Bidder nor any of its officers; partners, owners, agents, representatives, employees or parties in interest, including this affidavit, has in any way colluded, conspired, connived or agreed, directly or indirectly, with any other Bidder, firm or person to submit a collusive or sham Bid in connection with the Contract for which the attached Bid has been submitted or to refrain from bidding in connection with such Contract, or has in any manner, directly or indirectly, sought by agreement or collusion or communication of conference with any other Bidder, firm or person to fix the price or prices in the attached Bid or of any other Bidder, or to fix any overhead, profit or cost element of the Bid price or the Bid price of any other Bidder, or to secure through any collusion, conspiracy, connivance or unlawful agreement any advantage against the City of Reading or any person interested in the proposed Contract;

The price or prices quoted in the attached Bid are fair and proper and are not tainted by any collusion, conspiracy, connivance or unlawful agreement on the part of the Bidder or any of its agents, representatives, owners, employees, or parties in interest, including this affidavit; and,

Neither the said Bidder nor any of its officers, partners, owners, agents or parties in interest, have any interest, present or prospective, that can be reasonably construed to result in a conflict of interest between them and the City of Reading, which the Bidder will be required to perform.

I state that _____ understands

(Name of Firm)

and acknowledges that the above representations are material and important, and will be relied on by the City of Reading in awarding the contract(s) for which this bid is submitted. I understand and my firm understands that any misstatement in this affidavit is and shall be treated as fraudulent concealment from the City of Reading of the true facts relating to the submission of bids for this contract.

(Name and Company Position)

SWORN TO AND SUBSCRIBED

BEFORE ME THIS _____

DAY OF _____, 20____

Notary Public

My Commission Expires

STATEMENT OF BIDDER'S QUALIFICATIONS

All questions must be answered and the data given must be clear and comprehensive. This statement must be notarized. If necessary, questions may be answered on separate attached sheets. The Bidder may submit any additional information he desires.

1. Name of Bidder:_____
2. Permanent main office address:_____
3. When organized:_____
4. If a corporation, where incorporated:_____
5. How many years have you been engaged in the contracting business under your present firm or trade name:_____
6. Contracts on hand: (Schedule these on an attached sheet, showing amount of each contract and the appropriate anticipated dates of completion.)
7. Have you ever failed to complete any work awarded to you? If so, where and why?

8. Have you ever defaulted on a contract ? _____. If so, where and why?

9. List the more important projects recently completed by your company on an attached sheet, stating the approximate cost of each, and the month and year completed.
10. List your major equipment available for this contract.

11. Describe experience in construction work similar in importance to this project on an attached sheet.

Statement of Bidder's Qualifications

12. Background and experience of the principal members of your organization, including the officers.

13. Credit available: \$_____

14. Give Bank reference:_____

15. Will you, upon request, fill out a detailed financial statement and furnish any other information that may be required by the City? _____

16. (A) Have you ever been a party to or otherwise involved in any action or legal proceeding involving matters related to race, color, nationality or religion?_____

If so, give full details. _____

- (B) Have you ever been accused of discrimination based upon race, color, nationality or religion in any action or legal proceeding including any proceeding related to any Federal Agency? _____. If so, give full details _____

17. All prospective bidders are required to present proof of an acceptable disposal method approved by the Pennsylvania Department of Environmental Resources. The proof may consist of a copy of a State Solid Waste Disposal Permit issued to the prospective bidder by the Pennsylvania Department of Environmental Resources, or a letter of approval from the Pennsylvania Department of Environmental Resources for the use of a proposed or existing disposal facility which has a permit or is under review for a permit. Same to be in accordance with Section 7 (a) application and permits, Pennsylvania Solid Waste Management - "Act 241."

Statement of Bidder's Qualifications

18. Name, address, phone number, and contact person at surety company who will provide bonding for this contract:

19. Name, address, phone number, and contact person at insurance company who will provide insurance coverage for this contract:

20. The undersigned hereby authorizes any person, firm or corporation to furnish any information requested by the City of Reading in verification of the recitals comprising this Statement of Bidder's Qualifications.

DATED at _____ this _____ day of _____, 20 ____.

(NAME OF BIDDER)

BY: _____

TITLE: _____

NON DISCRIMINATION STATEMENT

The undersigned hereby certifies that it shall not discriminate against any employee or applicant for employment because of race, color, religion, sex, handicap, familial status, or national origin. The undersigned shall take affirmative action to insure that applicants for employment are employed, and that employees are treated during employment, without regard to their race, color, religion, sex, handicap, familial status, or national origin.

NAME

BIDDER

TITLE

CONTRACT DOCUMENTS

C O N T R A C T

NOTE; This contract is not to be filled in until contract is awarded.

THIS AGREEMENT, made and concluded this _____ day of _____, in the year two thousand and _____, by and between the City of Reading, a municipal corporation of the Commonwealth of Pennsylvania, located in the County of Berks, said Commonwealth, party of the first part, and _____, Contractor, party of the second part, pursuant to law and to the provisions and requirements of the ordinance of the City of Reading, Pennsylvania.

WITNESSETH, that the parties to these presents, each in consideration of the agreements on the part of the other herein contained, have agreed, and hereby do agree, the party of the first part for itself, its successors and assign, and the party of the second part for itself, himself, or themselves, its successors, or his or their executors and administrators as follows:

CONTRACTOR'S GENERAL AGREEMENT. The Contractor covenant, promises and agrees to and with the party of the first part, for the consideration hereinafter mentioned and contained, and under the penalty expressed in a bond bearing date of _____ and hereto attached, to furnish all the material, machinery, equipment, tools, labor and transportation, except as hereinafter otherwise provided, at his own cost, necessary or proper for the purpose of executing the work embraced in this contract in a good, substantial and workmanlike manner, and in strict accordance with the specifications pertaining to this contract a herein contained.

PARTS OF CONTRACT. Notice to Contractors; Bid Instructions; Documents to be Submitted with Bid; Contract Documents; Documents to be Submitted During the Course of the Contract; Notice of Preconstruction Requirements and Pre-Construction Conference Questionnaire; Affirmative Action Requirements; General Provisions; Supplementary General Terms and Conditions; Technical Specifications; and Correspondence and Supportive Documentation shall each form a part of the Contract.

THE CONTRACT SUM. The City shall pay the Contractor for the performance of the Contract, subject to additions and deductions provided therein, in current funds as follows:_____

_____ (state here the lump sum amount, unit prices, or both as desired in individual cases.)

Where the quantities originally contemplated are so changed that application of the agreed unit price to the quantity of work performed is shown to create a hardship to the Owner or the Contractor, there shall be an equitable adjustment of the Contract to prevent such hardship.

TIME & MANNER OF DOING WORK. The party of the second part agrees to commence the construction of the work to be done under this contract, within 100 calendar days upon receiving written notice from the Director of Public Works, or other applicable Director, so to do and to complete the entire work not later than 180 days after receiving written notice, with 40 consecutive days allowed for work on site, it being expressly agreed and understood that the time of beginning, rates of progress and time of completion of the work are essential under this contract. Time is to be considered to be the essence of this contract.

STIPULATED DAMAGES. The Contractor shall begin work within ten (10) days of receipt of written notice from the applicable Director, to do so. If the Contractor fails to complete and finish the work in conformity with the terms and provisions of this Contract within the time hereinbefore specified, he shall pay to the City the sum of ***Five Hundred Dollars (\$500.00)*** for each and every day thereafter, including Sundays and holidays, that the finishing of the Contract is delayed, which sum shall be construed as stipulated and liquidated damages and not as a penalty and shall be deducted from the amount due by the terms of the Contract; provided, however, that in case of justifiable delay, the City shall extend the time for completion of said work as provided for in Article G.7, but no extension of time for any reason beyond the time fixed herein for the completion of the work shall be deemed a waiver by the City of the right to abrogate this Contract for abandonment for delay.

LIENS. Neither the final payment nor any part of the retained percentage shall become due until the Contractor, if required, shall deliver to the City a complete release of all liens arising out of this Contract, or receipts in full in lien thereof, and, if required in either case, an affidavit that so far as he has knowledge or information the release and receipts include all the labor and material for which a lien could be filed. If any lien remains unsatisfied after all payments are made, the Contractor shall refund to the City all monies that the latter may be compelled to pay in discharging such a lien, including all costs and a reasonable attorney's fee.

BASIS OF CONTRACT. This contract is founded on _____

IN WITNESS WHEREOF, the said City of Reading has caused this Agreement to be executed by its Mayor, and its corporate seal to be hereunto affixed, duly attested by its City Clerk, and the party of the second part.

the day and year first above written.

CITY OF READING

By: _____
Mayor

ATTEST:

City Clerk

Signed and Sealed in the Presence of

CONTRACTOR

PRESIDENT

SECRETARY

PERFORMANCE BOND

Know All Men By These Presents that we, _____
(CONTRACTOR)

hereinafter called the PRINCIPAL, and _____
(SURETY)

hereinafter called the SURETY, a corporation organized and existing under the laws of
the _____ are held and firmly bound
unto _____ hereinafter called the OBLIGEE, as hereinafter set forth,

in the full and just sum of _____ Dollars (\$ _____), lawful money of
the United States of America, for the payment of which sum we bind ourselves, our heirs, executors,
administrators, successors and assigns, jointly and severally, firmly by these presents.

WITNESSETH THAT:

WHEREAS, the PRINCIPAL heretofore submitted to the OBLIGEE a certain PROPOSAL, dated
_____, 20____, to perform the WORK for the OBLIGEE, in connection with the
_____ as set forth in
CONTRACT DOCUMENTS.

WHEREAS, the OBLIGEE is a "contracting body" under provisions of Act No. 385 of the General
Assembly of the Commonwealth of Pennsylvania, approved by the Governor on December 20, 1967,
known and cited as the "Public Works Contractors Bond Law of 1967" (the "Act"); and

WHEREAS, the Act, in Section 3(a), requires that, before an award shall be made to the PRINCIPAL by
the OBLIGEE in accordance with the PROPOSAL, the PRINCIPAL shall furnish this BOND to the
OBLIGEE, with this BOND to become binding upon the award of the CONTRACT to the PRINCIPAL
by the OBLIGEE in accordance with the PROPOSAL; and

WHEREAS, it also is a condition of the CONTRACT DOCUMENTS that this BOND shall be furnished
by the PRINCIPAL to the OBLIGEE; and

WHEREAS, under the CONTRACTOR DOCUMENTS, it is provided inter alia, that if the PRINCIPAL
shall furnish this BOND to the OBLIGEE, and if the OBLIGEE shall make an award to the PRINCIPAL,
in accordance with the PROPOSAL, then the PRINCIPAL and OBLIGEE shall enter into a CONTRACT
with respect to performance of the WORK, the form of which CONTRACT is set forth in the CONTRACT
DOCUMENTS.

NOW, THEREFORE, the terms and conditions of this BOND are and shall be that if the PRINCIPAL will truly and faithfully comply with and perform the WORK in accordance with the CONTRACT DOCUMENTS, at the time and in the manner provided in the CONTRACT DOCUMENTS, and if the PRINCIPAL shall satisfy all claims and demands incurred in or related to the performance of the WORK by the PRINCIPAL, and if the PRINCIPAL shall indemnify completely and shall hold harmless the OBLIGEE and all of its officers, agents and employees from any and all costs and damages which the OBLIGEE and all of its officers, agents and employees may sustain or suffer by reason of the failure of the PRINCIPAL to do so, and if the PRINCIPAL shall reimburse completely and shall pay to the OBLIGEE any and all costs and expenses which the OBLIGEE and all of its officers, agents or employees may incur by reason of any such default or failure of the PRINCIPAL, then this BOND shall be void; otherwise, this BOND shall remain in force and effect.

This BOND, is executed and delivered under and subject to the Act, to which reference hereby is made.

The PRINCIPAL and the SURETY agree that any alterations, changes and/or additions to the CONTRACT DOCUMENTS, and/or any alterations, changes and/or additions to the WORK to be performed in accordance with the CONTRACT DOCUMENTS, and/or any alterations, changes and/or additions to the CONTRACT , and/or any giving by the OBLIGEE of any extensions of time for the performance of the WORK in accordance with the CONTRACT DOCUMENTS, and/or any act of forbearance of either the PRINCIPAL or the OBLIGEE toward the other with respect to the CONTRACT DOCUMENTS, and/or the reduction of any percentage to be retained by the OBLIGEE as permitted by the CONTRACT DOCUMENTS, shall not release, in any manner whatsoever, the PRINCIPAL and the SURETY, or either of them, or their heirs, executors, administrators, successors and assigns, from liability and obligations under this BOND; and the SURETY, for value received, does waive notice of any such alterations, changes, additions, extensions of time, acts of forbearance and/or reduction of retained percentage.

IN WITNESS WHEREOF, the PRINCIPAL and the SURETY cause this BOND to be signed, sealed and delivered this _____ day of _____, 20____.

(INDIVIDUAL PRINCIPAL)

_____(Seal)
(Signature of Individual)

Witness:

Trading and Doing Business as:

(PARTNERSHIP PRINCIPAL)

_____(Seal)
(Name of Partnership)

Witness:

By: _____(Seal)
(Partner)

Witness:

By: _____(Seal)
(Partner)

Witness:

By: _____(Seal)
(Partner)

Witness:

By: _____(Seal)
(Partner)

(CORPORATION PRINCIPAL)

Attest:

(Secretary)

(Name of Corporation)

By: _____
(President/Vice President)

(CORPORATE SEAL)

or (if appropriate)

(Name of Corporation)

By: _____
Authorized Representative

*Attach appropriate proof, dated as of the same date as the Bond, evidencing authority to execute in behalf of the corporation.

Signed _____

(Title)

Subscribed and sworn to before me on

this ____ day of _____, 20 ____

(Title)

My commission expires:

(CORPORATION SURETY)

(Name of Corporation)

By: _____
 ** (Attorney-in-fact)

Witness:

(Corporate Seal)

** Attach an appropriate power of attorney, valid and in effect as of the date of this affidavit, evidencing the authority of the Attorney-In-Fact to act in behalf of the corporation.

PAYMENT BOND

Know All Men by These Presents:

That We, _____ hereinafter called the PRINCIPAL, and _____
(CONTRACTOR)

_____ hereinafter called the SURETY, a corporation organized and
(SURETY)

existing under the laws of the _____ of _____ are held and firmly
bound unto _____, hereinafter called OBLIGEE, as hereinafter

(OBLIGEE)

set forth, in the full and just sum of _____ Dollars (\$ _____),
lawful money of the United States of America, for the payment of which we bind ourselves, our heirs,
executors, administrators, successors and assigns, jointly and severally, firmly by these presents:

Witnesseth That:

WHEREAS, the PRINCIPAL heretofore submitted to the OBLIGEE a certain PROPOSAL, dated
_____, 20 ____ to perform the WORK for the OBLIGEE, in connection with the
_____ as set forth in the
CONTRACT DOCUMENTS;

WHEREAS, the OBLIGEE is a "contracting body" under provisions of the Act of the General Assembly
of the Commonwealth of Pennsylvania, approved by the Governor on December 20, 1967, known as and
cited as the "Public Works Contractors" Bond Law of 1967", P L 869 (the Act"): and

WHEREAS, the Act, in section 3(a), requires that, before an award shall be made to the PRINCIPAL by
the OBLIGEE in accordance with the PROPOSAL, the PRINCIPAL shall furnish this BOND to the
OBLIGEE, with this BOND to become binding upon the award of a CONTRACT to the PRINCIPAL by
the OBLIGEE in accordance with the PROPOSAL: and

WHEREAS, it also is a condition of the CONTRACT DOCUMENTS that this BOND shall be furnished
by the PRINCIPAL to the OBLIGEE; and

WHEREAS, under the CONTRACTOR DOCUMENTS, it is provided, inter alia, that if the PRINCIPAL
shall furnish this BOND to the OBLIGEE, and if the OBLIGEE shall make an award to the PRINCIPAL
in accordance with the PROPOSAL then the PRINCIPAL and the OBLIGEE shall enter into a
CONTRACT with respect to performance of the WORK, the form of which CONTRACT is set forth in
the CONTRACT DOCUMENTS.

NOW, THEREFORE, the terms and conditions of this BOND are and shall be that if the PRINCIPAL and any SUBCONTRACTOR of the PRINCIPAL to whom any portion of the WORK shall be subcontracted, and if all assignees of the PRINCIPAL and of any such SUBCONTRACTOR, promptly shall pay or shall cause to be paid, in full all money which may be due any claimant supplying labor or materials in the prosecution and performance of the WORK in accordance with the CONTRACT DOCUMENTS, including any amendment, extension or addition to the CONTRACT DOCUMENTS, for material furnished or labor supplied or labor performed, then this BOND shall be void; otherwise, this BOND shall be and shall remain in force and effect.

This BOND, as provided by the Act, shall be solely for the protection of claimants supplying labor or materials to the PRINCIPAL or to any SUBCONTRACTOR of the PRINCIPAL in the prosecution of the WORK covered by the CONTRACT DOCUMENTS, including any amendment, extension or addition thereto. The term "claimant", where used herein and as required by the Act, shall mean any individual, firm, partnership, association or corporation. The phrase "labor or materials", when used herein and as required by the Act, shall include public utility services and reasonable rentals of equipment, but only for periods when the equipment rented is actually used at the site of the WORK covered by the CONTRACT. As required by the Act, the provisions of this BOND shall be applicable whether or not the material furnished or labor performed enters into and becomes a component part of the public building, public work or public improvement contemplated by the CONTRACT DOCUMENTS.

As provided and required by the Act, the PRINCIPAL and the SURETY agree that any claimant, who has performed labor or furnished material in the prosecution of the WORK in accordance with the CONTRACT DOCUMENTS, including any amendment, extension or addition to the CONTRACT DOCUMENTS, and who has not been paid therefore, in full, before the expiration of ninety (90) days after the last day on which such claimant performed the last of such labor or furnished the last of such materials for which payment is claimed, may institute an action upon this BOND, in the name of the claimant, in assumpsit, to recover any amount due the claimant for such labor or material, and may prosecute such action to final judgment and may have execution upon the judgment; provided, however, that:

- (a) Any claimant who has a direct contractual relationship with any SUBCONTRACTOR of the PRINCIPAL, but has no contractual relationship, express or implied, with the PRINCIPAL, may institute an action upon this BOND only if such claimant first shall have given written notice, served in the manner provided in the Act, to the PRINCIPAL, within ninety (90) days from the date upon which such claimant performed in the last of the labor or furnished the last of the materials for which payment is claimed, stating, with substantial accuracy, the amount claimed and the name of the person for whom the WORK was performed or to whom the material was furnished; and
- (b) No action upon this BOND shall be commenced after the expiration of one (1) year from the day upon which the last of the labor was performed or material was supplied, for the payment of which such action is instituted by the claimant; and
- (c) Every action upon this BOND shall be instituted either in the appropriate court of the County where the WORK is to be performed or of such other County as Pennsylvania statutes shall provide, or in the United States District Court for the district in which the PROJECT, to which the CONTRACT relates,

is situated, and not elsewhere.

This BOND is executed and delivered under and subject to the Act, to which reference hereby is made.

The PRINCIPAL and the SURETY agree that any alterations, changes and/or additions to the CONTRACT DOCUMENTS, and/or any alterations, changes and/or additions to the WORK to be performed in accordance with the CONTRACT DOCUMENTS, and/or any alterations, changes and/or additions to the CONTRACT, and/or any given by the OBLIGEE of any extensions of time for the performance of the WORK in accordance with the CONTRACT DOCUMENTS, and/or any act of forbearance of either the PRINCIPAL or the OBLIGEE toward the other with respect to the CONTRACT DOCUMENTS, and/or the reduction of any percentage to be retained by the OBLIGEE as permitted by the CONTRACT DOCUMENTS, shall not release, in any manner whatsoever, the PRINCIPAL and the SURETY, or either of them, or their heirs, executors, administrators, successors and assigns, from liability and obligations under this BOND; and the SURETY for value received, does waive notice of any such alterations, changes, additions, extensions of time, acts of forbearance and/or reduction of retained percentage.

If the PRINCIPAL is a foreign corporation (incorporated under the laws other than those of the Commonwealth of Pennsylvania) then further terms and conditions of this BOND are and shall be that the PRINCIPAL or the SURETY shall not be discharged from liability on this BOND, nor this BOND surrendered until such PRINCIPAL files with the OBLIGEE a certificate from the Pennsylvania Department of Revenue evidencing the payment in full of all bonus taxes, penalties and interest, and a certificate from the Bureau of Employment and Unemployment Compensation of the Pennsylvania Department of Labor and Industry, evidencing the payment of all unemployment compensation, contributions, penalties and interest due the Commonwealth from said PRINCIPAL or any foreign corporation,

SUBCONTRACTOR thereunder or for which liability has accrued but the time for payment has not arrived, all in accordance with provisions of the Act of June 10, 1947, P.L 493, of the Commonwealth of Pennsylvania.

In Witness Whereof, the PRINCIPAL and the SURETY cause this BOND to be signed, sealed and delivered this _____ day of _____, 20 ____.

(INDIVIDUAL PRINCIPAL)

_____(Seal)
(Signature of Individual)

Witness:

Trading and Doing Business as:

(PARTNERSHIP PRINCIPAL)

_____(Seal)
(Name of Partnership)

Witness:

By: _____(Seal)
(Partner)

Witness:

By: _____(Seal)
(Partner)

Witness:

By: _____(Seal)
(Partner)

Witness:

By: _____(Seal)
(Partner)

(CORPORATION PRINCIPAL)

Attest:

(Secretary)

(Name of Corporation)

By: _____
(President/Vice President)

(CORPORATE SEAL)

or (if appropriate)

(Name of Corporation)

By: _____
Authorized Representative

*Attach appropriate proof, dated as of the same date as the Bond, evidencing authority to execute in behalf of the corporation.

Signed _____

(Title)

Subscribed and sworn to before me on

this ____ day of _____, 20 ____

(Title)

My commission expires:

(CORPORATION SURETY)

(Name of Corporation)

By: _____
** (Attorney-in-fact

Witness:

(Corporate Seal)

**Attach an appropriate power of attorney, valid and in effect as of the date of this affidavit, evidencing the authority of the Attorney-In-Fact to act in behalf of the corporation.

MAINTENANCE BOND

Know All Men by These Presents, that we, _____
(CONTRACTOR)

hereinafter called the PRINCIPAL, and _____
(SURETY)

hereinafter called the SURETY, a corporation organized and existing under laws of the

_____ of _____, are held and

firmly bound unto _____, hereinafter called the OBLIGEE, as
(OWNER)

hereinafter set forth, in the full and just sum of _____

Dollars (\$ _____), lawful money of the United States of America, for the payment of which we bind ourselves, our heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents,

WITNESSETH THAT:

Whereas, The PRINCIPAL heretofore submitted to the OBLIGEE a certain
PROPOSAL, dated _____, 20__ to perform the WORK for the
OBLIGEE, in connection with the construction of _____

_____ as set forth in the CONTRACT DOCUMENTS as prepared by the CITY OF READING.

Now, Therefore, the condition of this BOND shall be such that: If the PRINCIPAL shall remedy, without cost to the OBLIGEE, all defects which may develop during the period of one (1) year from the date of completion by the PRINCIPAL and final acceptance of the OBLIGEE of the WORK performed in accordance with the CONTRACT DOCUMENTS, which defects, in the sole judgment of the OBLIGEE, shall be caused by or shall result from defective or inferior materials or workmanship, and if the PRINCIPAL shall satisfy all claims and demands arising from or related to such defects or growing out of such defects. and if the PRINCIPAL shall indemnify completely and shall save harmless the OBLIGEE from any and all costs and damages which the OBLIGEE may sustain or suffer by reason of the failure so to do; and if the PRINCIPAL shall reimburse completely and shall pay to the OBLIGEE any and all costs and expenses which the OBLIGEE may incur by reason of any such default or failure of the PRINCIPAL, then this BOND shall be void; otherwise, this BOND shall be and shall remain in full force and effect.

The PRINCIPAL and the SURETY agree that any alterations, changes and/or additions to the CONTRACT DOCUMENTS, and/or any alterations, changes and/or additions to the WORK to be performed in accordance with the CONTRACT DOCUMENTS, and/or any alterations, changes and/or additions to the CONTRACT, and/or any giving by the OBLIGEE of any extensions of time for the performance of the WORK in accordance with the CONTRACT DOCUMENTS, and/or any act of forbearance of either the PRINCIPAL or the OBLIGEE toward the other with respect to the CONTRACT DOCUMENTS, and/or the reduction of any percentage to be retained by the OBLIGEE as permitted by the CONTRACT DOCUMENTS, shall not release, in any manner whatsoever, the PRINCIPAL and the SURETY, or either of them, or their heirs, executors, administrators, successors and assigns from liability and obligations under this BOND; and the SURETY for value received, does waive notice of any such alterations, changes, additions, extensions of time, acts of forbearance and/or reduction of retained percentage.

In Witness Whereof, the PRINCIPAL and the SURETY cause this BOND to be signed, sealed and delivered this _____ day of _____, 20____.

(INDIVIDUAL PRINCIPAL)

_____(Seal)
(Signature of Individual)

Witness:

Trading and Doing Business as:

(PARTNERSHIP PRINCIPAL)

_____(Seal)
(Name of Partnership)

Witness:

By: _____(Seal)
(Partner)

Witness:

By: _____(Seal)
(Partner)

Witness:

By: _____(Seal)
(Partner)

Witness:

By: _____(Seal)
(Partner)

(CORPORATION PRINCIPAL)

Attest:

(Secretary)

(Name of Corporation)

By: _____
(President/Vice President)

(CORPORATE SEAL)

or (if appropriate)

(Name of Corporation)

By: _____
Authorized Representative

*Attach appropriate proof, dated as of the same date as the Bond, evidencing authority to execute in behalf of the corporation.

Signed _____

(Title)

Subscribed and sworn to before me on

this ____ day of _____, 20 ____

(Title)

My commission expires:

(CORPORATION SURETY)

(Name of Corporation)

By: _____
 ** (Attorney-in-fact)

Witness:

(Corporate Seal)

**Attach an appropriate power of attorney, valid and in effect as of the date of this affidavit, evidencing the authority of the Attorney-In-Fact to act in behalf of the corporation.

STATEMENT ACCEPTING PROVISIONS OF WORKERS' COMPENSATION ACT

STATE OF _____

ss.

COUNTY OF _____

The undersigned contractor has accepted the provisions of the Workers' Compensation Act of Pennsylvania, with all supplements, and has insured liability thereunder in accordance with the terms thereof with the insurance company whose signature is attached hereto.

For Individual

_____(SEAL)

For Corporation

(Name of Corporation)

By:_____
(Official Title)

Attest:_____
(Secretary or Asst. Secretary)

For Partnership

(Name of Partnership)

By:_____(SEAL)

_____(SEAL)
(Partners)

(Name of Insurance Company)

By:_____
Attorney-in-Fact

STIPULATION AGAINST LIENS

WHEREAS, _____, hereinafter called the CONTRACTOR,
has entered into a CONTRACT, dated _____, 20____, with
_____ hereinafter called the CITY, to
provide materials and perform labor necessary for the manufacture and furnishing of the: as set forth in
the CONTRACT DOCUMENTS as prepared by the City of Reading.

NOW, THEREFORE, it is hereby stipulated and agreed by and between the said parties, as part of
the said CONTRACT, and for the consideration therein set forth, that neither the undersigned
CONTRACTOR, any SUBCONTRACTOR or material man, nor any other person furnishing labor or
materials to the said CONTRACTOR under this CONTRACT shall file a lien, commonly called a
mechanic's lien, for WORK done or materials furnished for the above manufacture.

This stipulation is made and shall be filed with the Berks County Prothonotary within ten (10) days
after execution, in accordance with the requirements of Section 1402 of the Mechanics Lien Law of 1963
of the Commonwealth of Pennsylvania in such case provided.

IN WITNESS WHEREOF, the parties hereto have caused the signature of their proper officers to
be affixed thereto on this _____ day of _____, 20____.

(SEAL)

(CITY OF READING)

BY: _____

TITLE: _____

ATTEST:

BY: _____

TITLE: _____

(SEAL)

(CONTRACTOR)

BY: _____

TITLE: _____

ATTEST:

BY: _____

TITLE: _____

INDEMNITY AGREEMENT & HOLD HARMLESS

KNOW ALL MEN BY THESE PRESENTS:

WHEREAS, the undersigned has entered into a contract with the CITY OF READING, dated _____, 20 __, providing for the

City of Reading, Pennsylvania.

NOW, THEREFORE, in consideration of the award of said contract to the undersigned, _____, as well as in further consideration of the sum of ONE DOLLAR (\$1.00) in hand paid to the said _____ by the City of Reading, receipt whereof is hereby acknowledged, the said _____ agrees to indemnify and save harmless the CITY OF READING, its officers, agents, servants, and employees against any and all loss, damage, costs and expenses which the said CITY may hereafter suffer, incur, be put to or pay by reason of any bodily injury (including death) or damage to property arising out of any act or omission in performance of the work undertaken under the aforesaid contract.

EXECUTED this ____ day of _____, 20__.

By: _____

Title: _____

ATTEST:

(Title)

NOTICE TO PROCEED

TO:

Project_____

Contract No._____

Amount of Contract_____

You are hereby notified to commence work on the referenced contract on or before _____, 20____, and shall fully complete all of the work of said contract within 270 consecutive calendar days thereafter. Your completion date is therefore _____, 20_____.

The contract provides for an assessment of the sum of \$_____ as liquidated damages for each consecutive calendar day after the above established contract completion date that the work remains incomplete.

Dated this _____ day of _____, 20_____.

By_____

Title_____

ACCEPTANCE OF NOTICE

Receipt of foregoing Notice to Proceed is hereby acknowledged

By _____

this _____ day of _____, 20_____.

By _____

Title _____

GENERAL PROVISIONS

GENERAL PROVISIONS

G.1 SUB-HEADINGS. The paragraph headings are inserted in these provisions and the following specifications for convenience only and shall not be considered as interpreting or limiting the application of paragraphs.

G.2 DEFINITIONS. The following terms and expressions used in this contract and specifications shall be understood as follows:

The expression "The City" shall mean the City of Reading, Pennsylvania, the party of the first part to this contract.

The word "Engineer" shall mean the Engineer, Architect, or other official in direct charge of the work for the City or his authorized representative as designated by the applicable Director.

The word "Inspector" shall mean an inspector of the City assigned to the inspection of materials, structures and workmanship under this contract.

The word "Contractor" shall mean the party of the second part to this contract, whether a corporation, partnership, or individual.

The word "Specifications" shall mean the specifications describing the work, the drawings, and the general provisions.

The word "Drawings/Plans" shall mean the general drawings, plans, maps, diagrams or illustrations accompanying these specifications, and such supplementary drawings as may be furnished from time to time.

The term "Materials" as used herein includes, in addition, to materials incorporated in the project used or to be used in the operation thereof, equipment and other materials used and/or consumed in the performance of the work.

Wherever in the specifications the words "to be," "to be done," "if," "as," "directed," "required," "permitted," "ordered," "instructed," "designated," "considered necessary," or words of like import are used, it shall be understood that the direction, requirement, permission, order, instruction, designation or decision of the Engineer is intended, and similarly the words "approved," "acceptable," "satisfactory," or words of like import, shall mean approved by, acceptable or satisfactory to, the applicable Director or the Engineer, unless the context show that another meaning is plainly intended.

G.3 SPECIFICATIONS AND DRAWINGS. The specifications and drawings are intended to cover all of the work that is known to be required to effect a complete installation. They are intended to be mutually explanatory of each other, but should any discrepancy or inconsistency appear or any misunderstanding arise as to the import of anything contained in either the specifications or the drawings, the interpretation of the doubtful portions will be made by the Engineer, whose decision shall, in all cases, be final and binding on the Contractor.

Any materials or workmanship obviously necessary to satisfactory completion shall be furnished and installed whether or not specifically shown or mentioned. Any corrections of errors or omissions in the specifications or drawings, or both, may be made by the Engineer when such correction is necessary for the proper fulfillment of their intention as determined by him/her. Figures shall have preference over scale in reading dimensions. Copies of the specifications and drawings shall be kept constantly at the work. Any supplementary or detail drawings which may be made by the Engineer subsequent to the date of this contract, relating to the work herein contemplated, as showing more particularly the details of the work to be done, or specifications and the drawings furnished by the Contractor and approved by the Engineer, are, and are to be held to be, controlling parts of this contract insofar as they do not conflict with other provisions of the contract.

If the Contractor, in the course of the work, finds any discrepancy between the plans and the physical conditions of the locality, or any errors or omissions in the plans or in the layout as given by the points and instructions furnished by the Engineer, it shall be his duty to inform the Engineer, in writing, and the Engineer shall promptly verify the same. Any work done after such discovery, until authorized, will be done at the Contractor's risk.

G.4 ENGINEER TO DECIDE. All work under this contract shall be done in a manner acceptable to the Engineer, who shall determine the amount, quality, acceptability and fitness of the several kinds of work and material which are to be paid for hereunder, and shall decide all questions which may arise as to measurements of quantities and the fulfillment of the conditions of this contract on the part of the Contractor.

G.5 WORK TO BE DONE IN ACCORDANCE WITH SPECIFICATIONS AND DRAWINGS. The work at all stages of its completion must conform with the specifications and drawings and with the lines and grades and other instructions of the Engineer, as given from time to time during the progress of the work. In no case will any work in excess of the requirements of the drawings as interpreted by the Engineer be paid for unless authorized in writing by the Engineer.

G.6 RIGHT TO MAKE CHANGES IS RESERVED. The City reserves the right to make alterations in the location, lines, grade, plan, form dimensions, numbers or materials of the work herein contemplated, either before or after the commencement of construction. If such alterations diminish the amount of work to be done, they shall not form the basis for a claim for damage or for loss of anticipated profits from the work which may be dispensed with; if they increase the amount of work, such increase shall be paid for according to the quantity of work actually done and at prices stipulated for such work under this contract. All work actually done under a unit price (where applicable) contract, whether more or less than the quantity estimated or specified, shall be paid for by the determined units, on the basis of the bid per unit in the proposal.

G.7 EXTENSION OF TIME. If the Contractor is delayed at any time in the progress of the work by any act or neglect of the City, or by City employees, or by any other contractor employed by the City, or by changes ordered in the work, or by strikes, lockouts, fire, unusual delay in transportation, unavoidable casualties or any causes beyond the Contractor's control, or by any cause which the Engineer shall decide to justify the delay, then the time of completion shall be extended for such reasonable time as the Engineer

may decide subject to the approval of the applicable Director.

No such extension shall be made for delay due to rejection of defective materials or workmanship or for any delay occurring more than seven (7) days before claim therefore is made in writing to the Engineer. In the case of a continuing cause of delay, only one claim is necessary.

If no schedule or agreement stating dates upon which drawings shall be furnished is made, then no claim for delay shall be allowed because of any delay in the furnishing of drawings to the Contractor.

G.8 ADEQUATE PLANT AND METHODS. The Contractor shall furnish such construction plant and use such methods and appliances as will secure a satisfactory quality of work and a rate of progress which will insure the completion of the work within the time specified. Before starting the installation of the construction plant, the Contractor shall submit to the Engineer, for approval, a plan showing the general arrangement of the plant to be installed and the proposed facilities for storage of materials and equipment. If at any time the plant or any portion of it shall appear to the Engineer to be, or likely to become, inadequate, incomplete, faulty or unsafe, the Contractor shall promptly obey the orders of the Engineer to supplement or to remove or replace the same; but the failure of the Engineer to issue such orders shall not relieve the Contractor of his responsibility for the efficiency, adequacy and safe operation of the plant.

He shall cover and protect his work from damage, and all injury to the same, before completion of the contract.

He shall be financially responsible for all damage to the party of the first part or its property, to other contractors, to the neighboring premises, or to any private or personal property, for any cause whatsoever, during the period of the contract.

G.9 WORKERS. The Contractor shall employ only competent and skillful employees to do the work, and whenever the Engineer shall notify the Contractor, in writing, that any person on the work is, in his/her opinion, incompetent, unfaithful or disorderly, uses threatening or abusive language to any official having supervision of the work, or is in any other way unsatisfactory, such person shall be discharged from the work and shall not again be employed on it except with the consent of the Engineer.

Neither party shall employ or hire any employee of the other party without the latter's consent.

G.10 WAGES. All employees directly employed on this work shall be paid wages which shall in no event be less than the minimum hourly wage rates for skilled, semi-skilled, and unskilled labor prescribed by the Commonwealth of PA Prevailing Wage Act, P.L. 987 as may be amended, if applicable.

G.11 PENALTY FOR FAILURE TO LIVE UP TO MINIMUM WAGE CONTRACT. A penalty shall be exacted from the Contractor in an amount equal to twice the difference between the minimum wage contained in the prescribed wage rates, and the wage actually paid to each laborer or mechanic for each day during which he has been employed at a wage less than that prescribed.

G.12 INSPECTORS TO REPORT VIOLATIONS. Every person assigned as an Inspector of the work to be performed under this contract, in order to aid in enforcing the fulfillment of the minimum wage

requirements thereof, shall, upon observation or investigation, report to the applicable Director, all violations of minimum wage stipulations, together with the name of each laborer or mechanic who has been paid a wage less than that prescribed, and the day or days of such violation

G.13 PENALTIES TO BE WITHHELD FROM MONEYS DUE THE CONTRACTOR.

All minimum wage violation penalties shall be withheld and deducted for the use of the City from any moneys due the Contractor by the City; provided, that if the Contractor subsequently pays to all laborers and mechanics the balance of the amounts stipulated as minimum wages, the City shall pay to the Contractor the amounts so withheld.

G.14 CONTRACTOR'S RESPONSIBILITY FOR EMPLOYEES. The Contractor

hereby assumes all responsibility for himself/herself, his/her agents and employees growing out of connection with the execution of the work called for by this contract, for the violation of, City ordinances and the laws governing contract work in the Commonwealth of Pennsylvania. The Contractor further agrees to hold the City of Reading harmless from all responsibility for employees on this work under the Workmen's Compensation Act of the Commonwealth of Pennsylvania, and to carry insurance on his/her employees, as provided thereby.

G.15 CONTRACTOR REPRESENTED ON THE WORK. The Contractor shall give personal attention constantly to the faithful prosecution of the work and shall be present, either in person or by a competent superintendent, on the site of the work, continuously during its progress. Such representative shall have authority to receive and to act without delay upon all instructions of the Engineer or assistants in the prosecution of the work in conformity with the contract.

Insofar as it is practicable, all orders given by the Engineer to the Contractor shall be in writing. In those cases where orders are given orally they shall be confirmed in writing. Orders or directions, written or oral, from the Engineer, delivered to the Contractor's office shall be considered as delivered to the Contractor.

G.16 REPRESENTATIVE MUST BE PRESENT. In case the Engineer or a representative may at any time have occasion to give directions regarding the work for the reason that the same is not, in the Engineer's opinion, being carried out in accordance with the provisions of this contract, and should there be no responsible representative of the Contractor on the ground empowered to receive such instructions, the Engineer or a representative shall order that particular portion of the work to be stopped until such representative of the Contractor appears and receives instructions. It is hereby agreed that suspensions of the work for such cause shall not entitle the Contractor to claims for damage of any kind, nor to an extension of the time in which to complete the work to be done under this contract.

G.17 LEGAL ADDRESS OF CONTRACTOR. The address given in the bid or proposal upon which this contract is based is hereby designated as the legal address where all notices, letters and other communications to the Contractor shall be mailed or delivered prior to the beginning of the work provided for in this contract. The delivery at the above-named place, or depositing in a post-paid wrapper directed to the above place, in any post office box regularly maintained by the post office, of any notice, letter or other communication to the Contractor, shall be deemed sufficient service thereof upon the Contractor and the date of said service shall be the date of such delivery or mailing.

G.18 CHANGE IN ADDRESS. Such address may be changed at any time by an instrument in writing executed and acknowledged by the Contractor and delivered to the City. Nothing herein contained shall be deemed to preclude or render inoperative the service of any notice, letter or other communication upon the Contractor personally.

G.19 LAWS, ORDINANCES AND REGULATIONS. The Contractor shall be fully informed as to all laws, ordinances and regulations in any manner affecting those engaged or employed in the work, or the materials used in the work, or in any way affecting the conduct of the work, and of all orders and decrees of bodies or tribunals having any jurisdiction over the same, if any discrepancy or inconsistency shall be discovered in this contract, specifications or drawings, in relation to any such law, ordinance, population, order or decree, the contractor shall immediately report the same in writing to the Engineer. At all times the Contractor shall observe and comply with all laws, ordinances, regulations, orders and decrees which may be in effect during the progress of this contract; and shall indemnify and save harmless the City and its officers and employees against any claim or liability arising from the violation of any legal requirement in the prosecution of this contract.

G.20 INDEMNIFICATION OF CITY. In case any action at law, proceeding in eminent domain, or suit in equity may or shall be brought against the party of the first part, or any of its offices or agents, for or on account of the failure, omission or neglect of the Contractor or the subcontractors, his/her or their employees or agents, to do and perform any of the covenants acts, matters, or things by this contract undertaken to be done or performed by the Contractor or subcontractors, his/her or their employees or agents, or for any injury or damage caused by the negligence of the Contractor or subcontractors, his/her or their employees or agents, or for damage or injury for which the Contractor undertakes responsibility under the provisions of this contract, the Contractor shall immediately assume and take charge of the defense to such actions, proceedings or suits in like manner and to all intents and purposes, as if said actions, proceedings or suits had been brought directly against the Contractor; and the Contractor shall also indemnify and save harmless the party of the first part, its officers and agents, of and from all loss, cost or damage whatever arising out of such actions, proceedings or suits as may or shall be brought as aforesaid.

G.21 SUITS AND CLAIMS. The Contractor agrees to indemnify and save harmless the City of Reading, the applicable Director, the Engineer, and their assistants, from all suits or actions of every name and description, either in law or in equity, including proceedings in eminent domain for the recovery of consequential damages, or for or on account of use of patented appliance, brought against them or either of them, or for any damage or injuries received or sustained by any party or parties, person or persons, natural or artificial, either in the performance or as a result of the work under this agreement, regardless of whether such suits, actions or proceedings brought are based or grounded upon negligence of the Contractor, the subcontractors, or his/her or their agents, servants or employees. The Contractor further agrees that all or as much of the monies due under this agreement as shall be or may be considered necessary by the applicable Director, shall or may be retained, without any liability of the City to the Contractor, for interest thereon because of the retention thereof, until all such suits, proceedings or claims have been settled or terminated, and satisfactory evidence to that effect furnished to the applicable Director, provided however, that no such monies shall be retained by the City after six (6) years following the completion and acceptance of the work under the contract, excepting for or on account of claims filed or suits or proceedings begun before the expiration of the applicable statute of limitations.

G.22 RESPONSIBILITY FOR INJURY. The Contractor shall assume all responsibility for loss, damage or injury to persons or property arising out of the nature of the work, from the actions of the elements, or from any unforeseen or unusual difficulties over which the City has no control, in addition to and without limiting the Contractor's liability under the other provisions of the contract.

G.23 CONTRACTOR'S CLAIMS FOR DAMAGE. If the Contractor claims compensation for any damage alleged to have been sustained by reason of any act or omission on the part of the City or any of its agents, he shall, within one (1) week after the sustaining of such damage, make a written statement to the Engineer of the nature of the damage sustained, and shall, on or before the fifteenth (15th) day of the month succeeding that in which any such damage shall have been sustained, file with the Engineer an itemized statement of the details and amounts of such damage, and unless such statement shall be made as so required, the claim for compensation shall be forfeited and invalid, and the Contractor shall not be entitled to payment on account of any such damage.

G.24 LINES AND GRADES. All lines and grades will be given by the Engineer, but the Contractor shall provide such material and give such assistance therefore as may be required by the Engineer, and the marks so given shall be carefully preserved. The Contractor shall keep the Engineer informed, a reasonable time in advance, of the time and places at which he/she intends to work, in order that lines and grades may be furnished and necessary measurements for record and payment made with the minimum inconvenience to the Engineer or delay to the Contractor. No claim for extra payment will be allowed for the cost to the Contractor of any material, work or delay occasioned by giving lines and grades, or making necessary measurements or inspections, as all such cost shall be considered to have been included in the price bid for the work.

G.25 INSPECTION. The Engineer will appoint such person or persons as may be deemed necessary to inspect properly the materials furnished and the work done under this contract, and to see that the same correspond strictly with these specifications. Such materials and workmanship shall always be subject to the approval of the Engineer, but no inspection, approval or acceptance of any part of the work herein contracted for or of the materials used therein, nor any payment on account thereof, shall prevent the rejection of said work or materials at any time thereafter during the existence of this contract, should said work or materials be found to be defective, or not in accordance with the requirements of the contract.

The Contractor shall permit, or secure permission for the Engineer or a duly authorized Inspector or representative to enter any manufactory, shop or other place where any material for, or part of the work is being prepared, manufactured or constructed, at any time when such work is in progress. The Contractor shall furnish and prepare, or cause to be furnished or prepared, without charge, all such assistance, appliances, samples of materials and test specimens as may be ordered by the Engineer or such Inspector or representative for the purpose of making official tests and investigations. The Engineer shall be notified of the time and place of preparation, manufacture or construction of any material for, or part of the work which he/she may wish to inspect before delivery at the site of the work. Such notification shall be given a sufficient time in advance of the beginning of the work on such material or part to allow arrangements to be made for inspection and testing.

G.26 NIGHT WORK. No night work, except for the inspection of lighting, requiring the presence of the Engineer or Inspector will be permitted except in case of emergency, and then only with the written

consent of the Engineer and to such an extent as may be judged necessary.

G.27 SUNDAY WORK. No Sunday work will be permitted, except in case of great emergency, and then only with the written consent of the Engineer, and to such extent as is absolutely necessary.

G.28 NO WORK IN BAD WEATHER. No work shall be done under this contract when, in the opinion of the Engineer, the weather is unsuitable for good and careful work to be performed. No concrete work shall be done on days on which the temperature falls below 25 degrees Fahrenheit. Should the severity of the weather continue such that the work cannot be prosecuted successfully, the Contractor, upon order of the Engineer, shall cease all such work until directed to resume the same. In the latter case, suitable extension of time shall be allowed to compensate for time actually lost as provided for in Article G.7.

G.29. NOT TO SUBLET OR ASSIGN. The Contractor shall give personal attention constantly to the faithful prosecution of the work and shall not assign, transfer, convey, sublet or otherwise dispose of this contract, or his/her title, right or interest in or to the same or any part thereof, nor shall the Contractor assign, by power of attorney or otherwise, any of the monies due or to become due, nor issue any order or orders or drafts on the Controller or Treasurer of the City of Reading for any monies due or to become due under this contract, unless by and with the consent of the City first duly had and obtained by resolution entered upon the minutes of said City.

G.30 RIGHT OF PROPERTY IN MATERIALS. Nothing in this contract shall be considered as vesting in the Contractor any right of property in materials used, after they shall have been attached to or incorporated in the work, nor in materials which have been estimated for partial payment, but all such materials, upon being so attached, incorporated or estimated, shall become the property of the City.

G.31 DEFECTIVE MATERIALS AND WORKMANSHIP. No materials of any kind shall be used until they have been examined and approved by the Engineer, who shall have full power to condemn any work and materials not in accordance with the specifications, and to require the Contractor to remove any work or materials so condemned. Inspections of the work shall not relieve the Contractor from any of his/her obligations to fulfill the contract as herein described, and defective work shall be made good, and unsuitable materials may be rejected, notwithstanding that such work or materials may have been previously overlooked by the Engineer and accepted or estimated for payment if the work or any part thereof shall be found defective at any time before the final acceptance of the whole work, the Contractor shall immediately make good such defect in a manner satisfactory to the Engineer, and if any material brought upon the ground for use in the work shall be condemned by the Engineer as unsuitable or not in conformity with the drawings or specifications, the Contractor shall forthwith remove such materials from the vicinity of the work. If the Contractor shall fail to remove or replace any defective or damaged materials or work after reasonable notice, the Engineer may cause such material or work to be removed or replaced, and the expense thereof shall be borne by the Contractor.

G.32 RESPONSIBILITY FOR WORK. The Contractor shall be held responsible for any or all materials or work to the full amount of all payments made thereon, and shall be required to make good, at his/her own cost, any injury or damage which said materials or work may have sustained from any source or cause whatever before its final acceptance.

G.33 CONDITIONS UNDER WHICH CITY MAY COMPLETE WORK. If the work to be done under this contract shall be neglected or abandoned, or the contract or any claim thereunder shall be assigned by the Contractor otherwise than as herein specified, or if at any time the Engineer shall be of the opinion, and shall so certify in writing to the City's representative, that the rate of progress is insufficient or that the work, or any part thereof, is unnecessarily or unreasonably delayed, or that the Contractor is violating any of the provisions of this contract or carelessly executing any portion of the work, the City may notify the Contractor and surety in writing to fulfill the conditions of the Contract; and should the Contractor or the surety fail to comply with said notice within ten (10) days, the City may notify the Contractor and the surety to discontinue all work, or any part thereof; and thereupon the Contractor and the surety shall discontinue said work, or said part thereof as the City may designate; and the City may thereupon, by contract or otherwise, as it may determine, complete the work or such part thereof, and charge the expenses thereof to the Contractor or the surety; and may take possession of and use therein such materials, animals, machinery, equipment, implements and tools of every description as may be found upon the work. The expense so incurred shall be deducted and paid by the City out of any monies then due or to become due the Contractor under this contract; or any part thereof; and in case such expense is less than the sum which would have been payable under this contract if the same had been completed by the Contractor, the Contractor shall be entitled to receive the difference, and in case such expense shall exceed the latter sum, the Contractor or the surety shall pay the amount of such excess to the party of the first part.

G.34 ALL PARTS OF WORK COVERED. The Contractor further agrees that the following clauses relative to the construction of the work shall apply to each and all of the separate parts of the work, as though specially mentioned under the different headings in the specifications:

Delivery of Materials - The Contractor shall be entirely responsible for delivery of all materials to the site of the work, making the arrangements therefore.

Engineer Shall Measure - No work shall be covered over or filled in until it shall have been inspected by the Engineer.

Materials Properly Stored - The materials to be used in construction shall be protected from deterioration and damage, and shall be so disposed of as not to endanger the work and in such manner that full access may be had at all times to all work under construction or completed.

Surplus Materials Removed - All parts of the work shall be kept in as neat and orderly condition as circumstances will permit and upon completion of the work, all surplus materials, earth, sand, rubbish and refuse of every kind, and all tools, machinery, equipment and other materials belonging to the Contractor shall be removed from the construction works and adjoining premises so as to leave everything in an acceptable condition, within a week after receipt of final certificate.

G.35 ESTIMATED QUANTITIES APPROXIMATE. In unit price contracts, the quantities of the various classes of work to be done and materials to be furnished under this contract, as estimated by the Engineer and listed in Specifications, attached hereto, are approximate and only for the purpose of comparing, on a uniform basis, the bids offered for the work under this contract; and neither the City nor the Council nor any member of the Council of the City of Reading is to be held responsible if any of the said estimated

quantities shall be found to be not even approximately correct in the construction of the work; and the Contractor shall make no claim for damages on anticipated profits or loss of profit, because of a difference between the quantities of the various items of work actually done or materials actually furnished and the estimated quantities stated in the Specifications, or because of the entire omission of any of the quantities or items stated in the Specifications.

G.36 EXTRA WORK. The Contractor shall do any work not herein otherwise provided for which, in the opinion of the Engineer, is necessary for the proper completion of the work, but not such work will be allowed or paid for except on a written order of the Engineer, and there shall be no claim for extra work or materials or for damage sustained except under this Article. The extra work order issued by the Engineer shall specify the basis of payment for the extra work. Any extra work or changes in the work involving changes in the plans and/or specifications shall be approved by the applicable Director, prior to the execution of the work.

G.37 MONTHLY ESTIMATES. Current payments for work done under this contract will be made as follows: on invoices submitted by the Contractor and approved by the Engineer or Architect. Ten percent (10%) of each General Contractor invoice request shall be retained by the City on this contract until it is completed up to City codes and contract specifications and approved by a City Official or person representing a City Official Architect or Engineer.

It is further agreed and understood that inclusion of any portion of the work in the monthly estimate shall not be construed as final approval or acceptance of the same.

G.38 CONTRACTOR SHALL PREPARE FOR FINAL INSPECTION. Upon the completion of the work the Contractor shall tear down and remove all temporary buildings and structures built by the Contractor, remove and thoroughly clear away all debris, forms and surplus materials and leave the site of the work in a neat and satisfactory condition, and shall notify the Engineer when the work is ready for final inspection.

G.39 WORK TO BE PROPERLY PERFORMED. It is expressly understood that acceptance of work and materials during construction will not imply final acceptance of the work, if the final inspection shall disclose faulty workmanship or materials; and all work of whatever kind that, during its progress and before it is finally accepted, may become damaged from any cause, shall be repaired in a manner satisfactory to the Engineer or, if necessary, shall be broken up and removed and replaced with good and satisfactory work by the Contractor at his own expense. All work of every description shall be the best of its respective kind; and everything not particularly specified herein shall be done and finished in the best manner, and as is usual in first-class work of the several kinds.

Failure or neglect on the part of the Engineer, or any authorized agents to condemn or reject any bad or inferior work or materials shall not be construed to imply an acceptance of such work or materials, if such bad or inferior materials or work becomes evident at any time prior to the final acceptance of the work and the release of the Contractor by the Council of the City of Reading; nor shall it be construed as barring the City of Reading at any subsequent time from the recovery for damages of such sum of money as may

be needed to build a new all portions of the work in which fraud was practiced or improper materials hidden, whenever found.

G.40 ACCEPTANCE AND FINAL PAYMENT. Upon receipt of written notice that the work is ready for final inspection and acceptance, the Engineer or Architect shall promptly make such inspection, and when he/she finds the work acceptable under the contract fully performed he/she shall promptly issue a final certificate, over his/her own signature, stating that the work provided for in this contract has been completed and is accepted under the terms and conditions thereof, and the entire balance found to be due the Contractor, including the retained percentage, shall be paid to the Contractor within (30) days after the execution of said final certificate.

G.41 WAIVER. Neither acceptance by the City, or any of its officers or employees, nor any order, measurement or certificate by the Engineer, nor any order by the City Council for payment of money, nor any payment for, nor any extension of time, nor any possession taken by the City or its officers or employees, shall operate as a waiver of any portion of this contract or of any power herein reserved to the City, or of any right to damage herein provided; nor shall any waiver of any breach of this contract be held to be a waiver of any other or subsequent breach. All remedies provided in this contract shall be taken and construed as cumulative; that is, in addition to each and every other remedy herein provided.

G.42 ACCEPTANCE OF FINAL CERTIFICATE. The acceptance by the Contractor of payment of the final estimate shall be conclusive evidence of acceptance and approval of estimates, accounting and deductions, and of full payment by the City for all work, labor, materials and services done or furnished hereunder, and of full satisfaction, discharge, release and waiver of all claims and demand of; or on behalf of the Contractor against the City, arising out of this agreement and the execution thereof. It is hereby further agreed that the Contractor shall not be entitled to demand or receive payment except in the manner set forth in this contract; and the Contractor further agrees that the final payment of the amount due under this contract and payment of the bills rendered for work done and materials furnished in accordance with any alterations of the same, shall release the City of Reading from any and all claims and liabilities on account of the work performed and materials furnished under said contract, or any alteration thereof.

G.43 MAINTENANCE AFTER COMPLETION. The Performance Bond shall remain in force for one (1) year from the date of completion and acceptance of the work under this contract, as security against any and all damage which may result from defects of materials or workmanship which may become apparent prior to the expiration of the one-year maintenance period. During this period the Contractor shall, promptly upon notification from the Engineer, repair all breaks and failures due to defects of material or workmanship at his own expense. If the Engineer shall deem it necessary and shall so direct, such repairs shall be made within twenty-four (24) hours after service of notice. If the Contractor unnecessarily delays making repairs ordered, or if delay would cause serious loss or damage, the City may undertake to have such repairs made or defects repaired without previous notice, and the expense of such repairs shall be borne by the Contractor or the surety. The Contractor shall be responsible for any damage resulting to any person or property from any violation of the guarantee and from unnecessary delays in making repairs.

G.44 PRICES. The City agrees to pay, and the Contractor agrees to receive, the price specified in the proposal submitted, as full compensation for furnishing all the materials called for, and for all labor and use of all machinery, equipment and tools necessary for executing the work contemplated in this contract;

for all royalties, for patents and patented materials, appliances and processes; also for all loss or damage arising out of the nature of the work, or from the action of the elements, or from any unforeseen reasons, obstructions or difficulties which may be encountered in the prosecution of the work, for all risks of every description connected with the work, and for all expenses incurred by or in consequence of the suspension or discontinuance of said work as herein specified, and for well and faithfully completing the work, and the whole thereof, according to the specifications and drawings and the requirements of the Engineer under them.

G.45 NO EXTRA COMPENSATION. The Contractor further agrees not to ask, demand, sue for, or recover for any extra compensation, for any materials furnished or work done under this contract, beyond the amounts payable for the several classes of work or kinds of materials herein enumerated, which shall be actually performed and furnished at the prices therefore herein agreed upon and fixed.

G.46 CONTRACTOR TO TAKE OUT ALL PERMITS. The Contractor shall take out all necessary permits required by agencies of the City of Reading and/or all other governmental agencies; shall give all notices required by law or ordinances; shall pay all fees and charges incident to the due and lawful prosecution of the work covered by the contract, and shall comply with all laws and regulations relating to buildings and public highways. All permits shall be at his expense.

G.47 NO CLAIM FOR EXTRA WORK. No claim for extra work or material shall be allowed to the Contractor, unless before the performance of all such extra work the applicable Director shall have first authorized the same in writing, and the price or prices to be paid therefore shall first have been agreed upon in writing between the Director and the Contractor, and the same shall have been done or furnished under a written order from the Director given before the performance of such extra work or the furnishing of such extra materials. All claims for extra work or materials in any month shall be made to the Director in writing before the fifteenth (15th) day of the following month, and failing to make such claim within the time required, the right of the Contractor to extra pay for such extra work or materials shall be deemed to have been waived and forfeited.

G.48 WORK TO BE DONE TO THE SATISFACTION OF THE CITY ENGINEER. All the work under this contract shall be done to the satisfaction of the City Engineer, who shall in all cases determine the amount, quality, acceptability and fitness of the several amounts of work and materials which are to be paid for hereunder and shall decide all questions which may arise as to the measurement of quantities in the fulfillment of this contract on the part of the Contractor, and shall determine all questions respecting the true construction or meaning of the plans and specifications, and the determination and decision thereon shall be final and conclusive; and such determination and decision, in case any question shall arise, shall be a condition precedent to the right of the Contractor to receive any money hereunder.

G.49 ENGINEER TO INSPECT AND REJECT. The Engineer shall inspect the materials furnished and the work done, and see that the same strictly correspond to the specifications, and he shall at all times have free access to the works, storehouse and yard of the Contractor, and shall be privileged to take such samples therefrom as he may deem necessary; and if the work, or any material brought on the grounds for the use of the work, or selected for the same, shall be condemned by the Engineer, as unsuitable or not in

conformity with the specifications, the Contractor shall forthwith remove such materials from the work.

Before issuance of the final certificate the Contractor shall furnish evidence satisfactory to the Engineer that all payrolls, materials, bills and other indebtedness connected with the work have been paid.

It is understood and agreed by the parties hereto that the final estimate of the Engineer shall be evidence of the amount of work performed by the Contractor under and by virtue of this agreement, and shall be taken as the full measure of the compensation to be received by the Contractor. The aforesaid estimate shall be based upon the contract price for the furnishing of all the different materials and labor, and the performance of all the work mentioned in this contract, including the specifications, and where there may be any ambiguity therein, the Engineer's instructions shall be considered explanatory and the decision shall be final.

No inspection, approval or acceptance of any of the work herein contracted for, or of the materials used herein, or any payment on account thereof shall prevent the party of the first part from objecting to the acceptance of said work or materials at any time during the existence of this contract. Neither the inspection of the applicable Director, or Division Head, or the City Engineer or any of their employees nor any order, measurement or certificate by the City Engineer nor any order by the Director for the payment of money, nor any payment for, or acceptance of, the whole or any part of the work, by the Director of the Division of Planning, nor any extension of time, nor any possession taken by the Director or his employees, shall operate as a waiver of any provision of this contract, or any power herein reserved to the party of the first part, or of any right to damage herein provided; nor shall any waiver of any breach of this contract be held to be a waiver of any other subsequent breach.

Any remedy provided in this contract shall be taken and construed as cumulative; that is, in addition to each and every other remedy herein provided; and in addition to all other suits, actions or legal proceedings the party of the first part shall be entitled to as of right.

G.50 CONTRACTOR NOT TO DISCOMMODE PRIVATE COMPANIES. The Contractor shall afford while the work is underway, the necessary facilities to any and all companies owning railway tracks, pipes, subway ducts, or other surface, sub-surface or super-surface construction on the line of the work, in the preservation of the same from injury, all without charge therefore the expense to the City.

G.51 EXAMINATIONS. At any time before or after completion of the work, should the City Engineer require it, the Contractor shall make such openings, and to such extent, through such part or parts of the work, as the City Engineer may direct, and shall restore the work so distributed to the satisfaction of the City Engineer; and should the work, in the opinion of the City Engineer, whose decision shall be final and conclusive therein, be found faulty in any respect, the whole of the expense incurred thereby shall be defrayed by the Contractor, according to and upon the prices herein set forth, but if otherwise, by the City.

TECHNICAL SPECIFICATIONS

DRAWINGS

CERTIFICATE OF ACKNOWLEDGMENT OF RECEIPT OF ADDENDUM

THE CITY OF READING

ADDENDUM NO. 1

RFP: Reading Public Library Electrical and Mechanical Upgrades.

DUE DATE: November 10, 2021
3:00 P.M. Prevailing Time

This addendum must be signed, attached to, and returned with your proposal to the City of Reading by the time and date indicated ABOVE.

PLEASE BE ADVISED UPDATED DRAWINGS FOR THIS PROJECT HAVE BEEN POSTED TO THE PENNBID AND THE CITY OF READING WEBSITE.

I, HEREBY CERTIFY THAT THE CHANGES COVERED BY THIS ADDENDUM HAVE BEEN TAKEN INTO ACCOUNT.

Firm Name (Type or Print)_____

Authorized Signature _____

Title_____

Name (Type or Print)_____

Date_____

CERTIFICATE OF ACKNOWLEDGMENT OF RECEIPT OF ADDENDUM

THE CITY OF READING

ADDENDUM NO. 2

RFP: Reading Public Library Electrical and Mechanical Upgrades.

DUE DATE: November 10, 2021
3:00 P.M. Prevailing Time

This addendum must be signed, attached to, and returned with your proposal to the City of Reading by the time and date indicated ABOVE.

PLEASE BE ADVISED PREVAILING WAGE RATES FOR THIS PROJECT WILL BE POSTED 10 DAYS BEFORE PROJECT IS DUE.

I, HEREBY CERTIFY THAT THE CHANGES COVERED BY THIS ADDENDUM HAVE BEEN TAKEN INTO ACCOUNT.

Firm Name (Type or Print)_____

Authorized Signature _____

Title_____

Name (Type or Print)_____

Date_____

CERTIFICATE OF ACKNOWLEDGMENT OF RECEIPT OF ADDENDUM

THE CITY OF READING

ADDENDUM NO. 3

RFP: Reading Public Library Electrical and Mechanical Upgrades.

DUE DATE: November 10, 2021
3:00 P.M. Prevailing Time

This addendum must be signed, attached to, and returned with your proposal to the City of Reading by the time and date indicated ABOVE.

On drawing M-531 the basis of design control system is noted as Structureware as Manufactured by Schneider Electric. This addendum hereby expands on this to include an additional manufactured system, Niagara 4 Framework by Tridium and the associated Johnson Controls. This system is only approved if provided by an Authorized Factory Distributer of Johnson Controls Facility Explorer. Energy Equipment Controls LLC is hereby listed as an approved vendor for this Johnson Control System.

I, HEREBY CERTIFY THAT THE CHANGES COVERED BY THIS ADDENDUM HAVE BEEN TAKEN INTO ACCOUNT.

Firm Name (Type or Print)_____

Authorized Signature _____

Title_____

Name (Type or Print)_____

Date_____

CERTIFICATE OF ACKNOWLEDGMENT OF RECEIPT OF ADDENDUM

THE CITY OF READING

ADDENDUM NO. 4

RFP: Reading Public Library Electrical and Mechanical Upgrades.

DUE DATE: November 10, 2021
3:00 P.M. Prevailing Time

Please be advised the Wage Rates for this project will be posted 10 days prior to the bid due date.

This addendum must be signed, attached to, and returned with your proposal to the City of Reading by the time and date indicated ABOVE.

Q1. May we have a range of probable cost?

A1. There was formal no estimate available at this time.

Q2. Please provide a project serial number to determine prevailing wage rates or provide prevailing wage rate information

A2. See Addendum #2

Q3. What is the estimated cost?

A3. There was formal no estimate available at this time.

Q4. Page M-103 is missing from the drawings.

A4. PennBid Drawing set (Rev 10-7-21) contains sheet M-103.

Q5. ITB indicates TE project. Will City be providing it's Tax ID number to successful contractors?

A5. The city will extend its Tax Exempt number.

Q6. ITB indicates TE project. Will City be providing it's Tax ID number to successful contractors?

A6. The city will extend its Tax Exempt number.

Q7. Is there a budget for each contract?

A7. There was formal no estimate available at this time.

Q8. The bid form asks for 2 totals, a lump sum, and a contingency. What should be entered for the contingency?

A8. The lump sum value should be the contractors bid. All contractors are being allotted the same contingency fund as follows:

CONTRACT 1 BASIS OF BID – MECHANICAL UPGRADES Contingency: \$15,000

CONTRACT 2 BASIS OF BID – UPGRADES Contingency: \$20,000

Total bid price is addition of Contractors bid and applicable contingency.

Q9. Please provide the prevailing wage rates for this project.

A9. See Addendum #2

Q10. We have downloaded addendum 1 from PennBid however the only sheet included is an acknowledgment receipt. What does this addendum include? Please advise.

A10. The addendum sheet #1 is an acknowledgment that the contractor has viewed the update drawings located in the drawing tab.

Q11. Would you accept Johnson FX Explorer controls? This is a full non proprietary system and street purchasable. We brought this question up at the pre-bid meeting.

A11. See Addendum #3.

Q12. Addendum #1 was issued however there is only an acknowledgment form. There is no narrative/specification or drawing attached or referred to.

A12. The addendum sheet #1 is an acknowledgment that the contractor has viewed the update drawing located in the drawing tab.

Q13. Does this job fall under the PA Steel Act or any other federal steel requirements?

A13. Yes, the Steel act applies to this project.

I, HEREBY CERTIFY THAT THE CHANGES COVERED BY THIS ADDENDUM HAVE BEEN TAKEN INTO ACCOUNT.

Firm Name (Type or Print)_____

Authorized Signature _____

Title_____

Name (Type or Print)_____

Date_____

CERTIFICATE OF ACKNOWLEDGMENT OF RECEIPT OF ADDENDUM

THE CITY OF READING

ADDENDUM NO. 5

RFP: Reading Public Library Electrical and
Mechanical Upgrades.

DUE DATE: November 10, 2021
3:00 P.M. Prevailing Time

This addendum must be signed, attached to, and returned with your proposal to the City of Reading by the time and date indicated ABOVE.

Prevailing Wage Rates now posted on Pennbid under prevailing wage rate tab.

Please sign and return this document as confirmation that you received the prevailing wage rates.

I, HEREBY CERTIFY THAT THE CHANGES COVERED BY THIS ADDENDUM HAVE BEEN TAKEN INTO ACCOUNT.

Firm Name (Type or Print)_____

Authorized Signature _____

Title_____

Name (Type or Print)_____

Date_____

PROPOSAL
FOR
READING PUBLIC LIBRARY
5TH AND FRANKLIN STREETS
ELECTRICAL AND MECHANICAL UPGRADES
CITY OF READING, PENNSYLVANIA

Proposal of

Brendan Stanton, Inc. dba BSI Electrical Contractors

(name)

416 Stump Road, Montgomeryville, PA 18936

(address)

TO: Mayor Eddie Moran
City of Reading
815 Washington Street
Reading, PA 19601

Dear Mayor Moran:

In conformity with City Plans and specifications, all as prepared by the Public Works Department and after an examination of the site of the work, and the Contract Documents, including the instructions to Bidders, Form of Proposal, Bid Bond and Conditions, the undersigned submits this proposal, and encloses herewith as proposal guaranty, a Certified or Treasurer's Check, or Bid Bond, in an amount not less than ten percent (10%) of the bid herein submitted, which it is understood will be forfeited if this proposal is accepted by the City of Reading, and the undersigned fails to furnish approved bonds and execute the contract within the time stipulated; otherwise, the guarantee will be returned.

The undersigned declares that no Member of Council, Director of Department, Division Manager, deputy thereof or clerk therein, or other officer of the City of Reading, is directly or indirectly interested as principal, surety or otherwise in this proposal or has any supervision or overall responsibility for the implementation in administration of the contract.

It is certified that the undersigned is the only person(s) interested in this proposal as principal and that the proposal is made without collusion with any person, firm, or corporation.

It is hereby agreed to execute the contract and furnish surety company bonds, on the forms enclosed in the Contract Documents, in the amount of one hundred percent (100%) of the contract price within ten

(10) days of mailing of the contract documents from the City to the Principal, and to begin work within ten (10) days after receipt of Notice to Proceed from the City of Reading.

CONTRACT 1

BASIS OF BID – MECHANICAL UPGRADES

LUMP SUM BID

Bidder will complete the Work in accordance with the Contract Documents for the following lump sum (stipulated) price:

Contingency: \$ _____

Lump Sum Bid Price: \$ _____

TOTAL BID PRICE \$ _____

RECEIPT OF ADDENDA

Bidder hereby acknowledges receipt of the following Addenda:

Addendum Number	Addendum Date

CONTRACT 2**BASIS OF BID – UPGRADES****LUMP SUM BID:**

Bidder will complete the Work in accordance with the Contract Documents for the following lump sum (stipulated) price:

Contingency:	\$ 20,000.00
Lump Sum Bid Price:	\$ 532,750.00
<u>TOTAL</u>	\$ 552,750.00

RECEIPT OF ADDENDA

Bidder hereby acknowledges receipt of the following Addenda:

Addendum Number	Addendum Date
#1	10/7/21
#2	10/13/21
#3	10/14/21
#4	10/28/21
#5	11/1/21

IN WITNESS WHEREOF, this proposal has been executed this 10th day of Nov, 20 21, by the setting hereunto of his or its hand and seal.

FOR INDIVIDUAL:

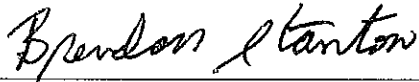
_____(Seal)

FOR CORPORATION:

Brendan Stanton, Inc. dba
BSI Electrical Contractors

(Name of Corporation)

By:



(Official Title)

Brendan Stanton
President/Secretary

FOR PARTNERSHIP:

(Name of Partnership)

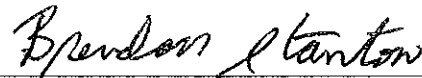
By:

_____(Seal)

_____(Seal)

Partners

Attest:



(Secretary) Brendan Stanton
President/Secretary

FORM OF BID BOND

BOND

KNOW ALL MEN BY THESE PRESENTS that we, the undersigned, Brendan Stanton, Inc.
t/a BSI Electrical Contractors, as Principal (the "Principal"), and Arch Insurance Company
 _____ a corporation organized and existing under laws
 of the state of Missouri, as Surety (the "Surety"), are held and firmly bound
 unto City of Reading as Obligee (the "Obligee"), as hereinafter set
 forth, in the full and just sum of 10% of total amount bid Dollars (\$____), lawful money of the
 United States of America, for the payment of which sum we bind ourselves, our heirs, administrators,
 executors, successors and assigns, jointly and severally, firmly by these presents.

WITNESSETH THAT:

WHEREAS, the Principal herewith is submitting a Proposal to the Obligee to perform the Work
 in connection with the construction of Reading Library Electrical & Mechanical
Upgrades Project
 pursuant to plans, specifications and other documents constituting the Contract Documents which are
 incorporated into said Proposal by reference (the "Contract Documents"), as prepared by the Department
 of Public Works, City Hall, 815 Washington Streets, Reading, PA 19601.

WHEREAS, it is a condition of the receipt and consideration by the Obligee of said Proposal that
 it shall be accompanied by proposal guaranty to be held by the Obligee on terms hereinafter set forth.

NOW, THEREFORE, the condition of this Bond shall be such that, if the Principal, within ten (10)
 days after mailing of contract document by the City to Principal, shall furnish to the Obligee a Performance
 Bond, Payment Bond and a Wage Rate Compliance Bond, and upon award of a contract to him by the
 Obligee, shall execute and deliver the Agreement and furnish to the Obligee proper evidence of
 effectiveness of insurance coverage, respectively within the time, in the forms and in the amounts, as
 appropriate, required by the Contract Documents, then this Bond shall be void, otherwise, this Bond shall
 remain in full force and effect.

The Principal and the Surety agree to pay to the Oblige the difference between the amount of said Proposal, as accepted by the Oblige, and any higher amount for which the required work shall be contracted for by the Oblige, together with any additional advertising costs, architect's fees, legal fees and any all other fees and expenses incurred by the Oblige by reason of the failure of the Principal to enter into such Agreement with the obligee, or to furnish such Contract Bonds, or to furnish evidence of effectiveness of such insurance coverage; provided, however, that (1) the obligation of the Surety shall not exceed the stated principal amount of this Bond; and (2) if the Oblige should not procure an executed contract with any other person for the performance of the work contemplated in said Proposal, as accepted by the Oblige, upon the same terms and conditions, other than price, as provided in the Contract Documents, within the period provided in the Contract Documents during which no proposals of bidders may be withdrawn, whether because of the lack of other proposals, or because of the inability or refusal of any other bidder to enter into an appropriate contract, or because the cost under any higher proposal would be greater than the Oblige shall determine, in its sole discretion, that it can afford, then the Principal and the Surety agree to pay to the Oblige the full amount of this Bond as liquidated damages.

IN WITNESS WHEREOF, the Principal and the Surety cause this Bond to be signed, sealed and delivered this 10th day of November, 2021.

(INDIVIDUAL PRINCIPAL)

_____(Seal)
(Signature of Individual)

Witness:

Trading and Doing Business as:

(PARTNERSHIP PRINCIPAL)

(Name of Partnership) (Seal)

Witness:

By: _____ (Seal)
(Partner)

Witness:

By: _____ (Seal)
(Partner)

Witness:

By: _____ (Seal)
(Partner)

Witness:

By: _____ (Seal)
(Partner)

(CORPORATION PRINCIPAL)

Attest:

Brendan Stanton
(Secretary)

Brendan Stanton, Inc. t/a BSI Electrical Contractors
(Name of Corporation)

By: Brendan Stanton
(President/Vice President)

(CORPORATE SEAL)

or (if appropriate)

(Name of Corporation)

By: _____
Authorized Representative

*Attach appropriate proof, dated as of the same date as the Bond, evidencing authority to execute in behalf of the corporation.

Signed _____

(Title)

Subscribed and sworn to before me on

this ____ day of _____, 20 ____

(Title)

My commission expires:

(CORPORATION SURETY)

Arch Insurance Company

(Name of Corporation)

By: Gina M. Semonelle

** (Attorney-in-fact)

Gina M. Semonelle

Witness:

[Signature]

(Corporate Seal)

** Attach an appropriate power of attorney, valid and in effect as of the date of this affidavit, evidencing the authority of the Attorney-In-Fact to act in behalf of the corporation.

CONSENT OF SURETY

We, the undersigned surety, Arch Insurance Company

**a corporation organized and existing under the State of Missouri
are hereby authorized to do business in the State of Pennsylvania
do hereby consent and agree with City of Reading**

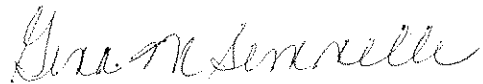
that if the foregoing proposal of Brendan Stanton, Inc. t/a BSI Electrical Contractors

**for Reading Library Electrical & Mechanical
Upgrades Project**

**be accepted and the contract timely awarded and executed by the Obligee and Principal,
that we will, as surety, upon its being so awarded and entered into, become surety for
the said project in the sum not to exceed 100% for the faithful performance of said
contract.**

Signed and dated: November 10, 2021

Arch Insurance Company
(Surety)



Gina M. Semonelle
Attorney-in-Fact

This Power of Attorney limits the acts of those named herein, and they have no authority to bind the Company except in the manner and to the extent herein stated. Not valid for Note, Loan, Letter of Credit, Currency Rate, Interest Rate or Residential Value Guarantees.

POWER OF ATTORNEY

Know All Persons By These Presents:

That the Arch Insurance Company, a corporation organized and existing under the laws of the State of Missouri, having its principal administrative office in Jersey City, New Jersey (hereinafter referred to as the "Company") does hereby appoint:

Brent D. Headley, Denise A. Medlar, Gina M. Semonelle, Joseph T. Catania, Mary Lawrence and Richard G. Anderson of Wilmington, DE (EACH)

its true and lawful Attorney(s) in-Fact, to make, execute, seal, and deliver from the date of issuance of this power for and on its behalf as surety, and as its act and deed: Any and all bonds, undertakings, recognizances and other surety obligations, in the penal sum not exceeding Ninety Million Dollars (\$90,000,000.00). This authority does not permit the same obligation to be split into two or more bonds in order to bring each such bond within the dollar limit of authority as set forth herein.

The execution of such bonds, undertakings, recognizances and other surety obligations in pursuance of these presents shall be as binding upon the said Company as fully and amply to all intents and purposes, as if the same had been duly executed and acknowledged by its regularly elected officers at its principal administrative office in Jersey City, New Jersey.

This Power of Attorney is executed by authority of resolutions adopted by unanimous consent of the Board of Directors of the Company on December 10, 2020, true and accurate copies of which are hereinafter set forth and are hereby certified to by the undersigned Secretary as being in full force and effect:

"VOTED, That the Chairman of the Board, the President, or the Executive Vice President, or any Senior Vice President, of the Surety Business Division, or their appointees designated in writing and filed with the Secretary, or the Secretary shall have the power and authority to appoint agents and attorneys-in-fact, and to authorize them subject to the limitations set forth in their respective powers of attorney, to execute on behalf of the Company, and attach the seal of the Company thereto, bonds, undertakings, recognizances and other surety obligations obligatory in the nature thereof, and any such officers of the Company may appoint agents for acceptance of process."

This Power of Attorney is signed, sealed and certified by facsimile under and by authority of the following resolution adopted by the unanimous consent of the Board of Directors of the Company on December 10, 2020:

VOTED, That the signature of the Chairman of the Board, the President, or the Executive Vice President, or any Senior Vice President, of the Surety Business Division, or their appointees designated in writing and filed with the Secretary, and the signature of the Secretary, the seal of the Company, and certifications by the Secretary, may be affixed by facsimile on any power of attorney or bond executed pursuant to the resolution adopted by the Board of Directors on December 10, 2020, and any such power so executed, sealed and certified with respect to any bond or undertaking to which it is attached, shall continue to be valid and binding upon the Company. In Testimony Whereof, the Company has caused this instrument to be signed and its corporate seal to be affixed by their authorized officers, this 22nd day of July, 2021.

Attested and Certified

Regan A. Shulman

Regan A. Shulman, Secretary

STATE OF PENNSYLVANIA SS
COUNTY OF PHILADELPHIA SS

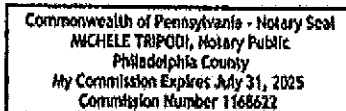


Arch Insurance Company

Stephen C. Ruschak

Stephen C. Ruschak, Executive Vice President

I, Michele Tripodi, a Notary Public, do hereby certify that Regan A. Shulman and Stephen C. Ruschak personally known to me to be the same persons whose names are respectively as Secretary and Executive Vice President of the Arch Insurance Company, a Corporation organized and existing under the laws of the State of Missouri, subscribed to the foregoing instrument, appeared before me this day in person and severally acknowledged that they being thereunto duly authorized signed, sealed with the corporate seal and delivered the said instrument as the free and voluntary act of said corporation and as their own free and voluntary acts for the uses and purposes therein set forth.



Michele Tripodi

Michele Tripodi, Notary Public
My commission expires 07/31/2025

CERTIFICATION

I, Regan A. Shulman, Secretary of the Arch Insurance Company, do hereby certify that the attached Power of Attorney dated July 22, 2021 on behalf of the person(s) as listed above is a true and correct copy and that the same has been in full force and effect since the date thereof and is in full force and effect on the date of this certificate; and I do further certify that the said Stephen C. Ruschak, who executed the Power of Attorney as Executive Vice President, was on the date of execution of the attached Power of Attorney the duly elected Executive Vice President of the Arch Insurance Company.

IN TESTIMONY WHEREOF, I have hereunto subscribed my name and affixed the corporate seal of the Arch Insurance Company on this 10th day of November 2021.

Regan A. Shulman

Regan A. Shulman, Secretary

This Power of Attorney limits the acts of those named therein to the bonds and undertakings specifically named therein and they have no authority to bind the Company except in the manner and to the extent herein stated.

PLEASE SEND ALL CLAIM INQUIRIES RELATING TO THIS BOND TO THE FOLLOWING ADDRESS:

Arch Insurance - Surety Division
3 Parkway, Suite 1500
Philadelphia, PA 19102



To verify the authenticity of this Power of Attorney, please contact Arch Insurance Company at SuretyAuthentic@archinsurance.com
Please refer to the above named Attorney-in-Fact and the details of the bond to which the power is attached.

NON-COLLUSION AFFIDAVIT

INSTRUCTIONS FOR NON-COLLUSION AFFIDAVIT

This Non-Collusion Affidavit is material to any contract pursuant to this bid. According to the Pennsylvania Antibid-Rigging Act, 73 P.S. 1611 et seq., governmental agencies may require Non-Collusion Affidavits to be submitted together with bids.

This Non-Collusion affidavit must be executed by the member, officer, or employee of the bidder who is authorized to legally bind the bidder.

Bid rigging and other efforts to restrain competition, and the making of false sworn statements in connection with the submission of bids are unlawful and may be subject to criminal prosecution. The person who signs the Affidavit should examine it carefully before signing and assure himself or herself that each statement is true and accurate, making diligent inquiry, as necessary, of all other persons employed by or associated with the bidder with responsibilities for the preparation, approval, or submission of the bid.

In the case of a bid submitted by a joint venture, each party to the venture must be identified in the bid documents, and an Affidavit must be submitted separately on behalf of each party.

The term "complementary bid" as used in the Affidavit has the meaning commonly associated with that term in the bidding process, and includes the knowing submission of bids higher than the bid of another firm, any intentionally high or noncompetitive bid, and any form of bid submitted for the purpose of giving a false appearance of competition.

Failure to file an Affidavit in compliance with these instructions will result in disqualification of the bid.

NON-COLLUSION AFFIDAVIT OF PRIME BIDDER

State of Pennsylvania

County of Montgomery

Brendan Stanton, being first duly sworn, deposes and says that:

He/She is Owner, President/Secretary

(Owner, Partner, Officer, Representative or Agent)

of Brendan Stanton, Inc. dba BSI Electrical Contractors the Bidder that has submitted the attached Bid or Bids;

He/She is fully informed respecting the preparation and contents of the attached Bid and of all pertinent circumstances respecting such Bid;

Such Bid is genuine and is not a collusive or sham Bid;

Neither the said Bidder nor any of its officers; partners, owners, agents, representatives, employees or parties in interest, including this affidavit, has in any way colluded, conspired, connived or agreed, directly or indirectly, with any other Bidder, firm or person to submit a collusive or sham Bid in connection with the Contract for which the attached Bid has been submitted or to refrain from bidding in connection with such Contract, or has in any manner, directly or indirectly, sought by agreement or collusion or communication of conference with any other Bidder, firm or person to fix the price or prices in the attached Bid or of any other Bidder, or to fix any overhead, profit or cost element of the Bid price or the Bid price of any other Bidder, or to secure through any collusion, conspiracy, connivance or unlawful agreement any advantage against the City of Reading or any person interested in the proposed Contract;

The price or prices quoted in the attached Bid are fair and proper and are not tainted by any collusion, conspiracy, connivance or unlawful agreement on the part of the Bidder or any of its agents, representatives, owners, employees, or parties in interest, including this affidavit; and,

Neither the said Bidder nor any of its officers, partners, owners, agents or parties in interest, have any interest, present or prospective, that can be reasonably construed to result in a conflict of interest between them and the City of Reading, which the Bidder will be required to perform.

Brendan Stanton, Inc. dba

I state that BSI Electrical Contractors understands
(Name of Firm)

and acknowledges that the above representations are material and important, and will be relied on by the City of Reading in awarding the contract(s) for which this bid is submitted. I understand and my firm understands that any misstatement in this affidavit is and shall be treated as fraudulent concealment from the City of Reading of the true facts relating to the submission of bids for this contract.

Brendan Stanton

(Name and Company Position)

Brendan Stanton

President/Secretary

SWORN TO AND SUBSCRIBED

BEFORE ME THIS 10th

DAY OF Nov, 2021

Melissa Reynolds
Notary Public

My Commission Expires

7/23/2022

Commonwealth of Pennsylvania - Notary Seal
Melissa Reynolds, Notary Public
Montgomery County
My commission expires July 23, 2022
Commission number 1191586
Member, Pennsylvania Association of Notaries

NON DISCRIMINATION STATEMENT

The undersigned hereby certifies that it shall not discriminate against any employee or applicant for employment because of race, color, religion, sex, handicap, familial status, or national origin. The undersigned shall take affirmative action to insure that applicants for employment are employed, and that employees are treated during employment, without regard to their race, color, religion, sex, handicap, familial status, or national origin.



NAME

Brendan Stanton, Inc dba

BSI Electrical Contractors

BIDDER

Brendan Stanton

President/Secretary

TITLE

STATEMENT OF BIDDER'S QUALIFICATIONS

All questions must be answered and the data given must be clear and comprehensive. This statement must be notarized. If necessary, questions may be answered on separate attached sheets. The Bidder may submit any additional information he desires.

1. Name of Bidder: Brendan Stanton, Inc. dba BSI Electrical Contractors
2. Permanent main office address: 416 Stump Road, Montgomeryville, PA 18936
3. When organized: 1977, Incorporated 2/1/1982
4. If a corporation, where incorporated: PA
5. How many years have you been engaged in the contracting business under your present firm or trade name: 44
6. Contracts on hand: (Schedule these on an attached sheet, showing amount of each contract and the appropriate anticipated dates of completion.)
7. Have you ever failed to complete any work awarded to you? If so, where and why?
NO
8. Have you ever defaulted on a contract ? NO. If so, where and why?

9. List the more important projects recently completed by your company on an attached sheet, stating the approximate cost of each, and the month and year completed.
10. List your major equipment available for this contract.
PLEASE SEE
ATTACHED

11. Describe experience in construction work similar in importance to this project on an attached sheet.
SEE ATTACHED
SIMILAR
PROJECTS

Statement of Bidder's Qualifications

12. Background and experience of the principal members of your organization, including the officers.

PLEASE SEE
ATTACHED

13. Credit available: \$ 1 MILLION

14. Give Bank reference: PNC BANK - Brian Skrip - (215) 328 - 2572

15. Will you, upon request, fill out a detailed financial statement and furnish any other information that may be required by the City? YES

16. (A) Have you ever been a party to or otherwise involved in any action or legal proceeding involving matters related to race, color, nationality or religion? NO

If so, give full details. _____

- (B) Have you ever been accused of discrimination based upon race, color, nationality or religion in any action or legal proceeding including any proceeding related to any Federal Agency? NO. If so, give full details _____

17. All prospective bidders are required to present proof of an acceptable disposal method approved by the Pennsylvania Department of Environmental Resources. The proof may consist of a copy of a State Solid Waste Disposal Permit issued to the prospective bidder by the Pennsylvania Department of Environmental Resources, or a letter of approval from the Pennsylvania Department of Environmental Resources for the use of a proposed or existing disposal facility which has a permit or is under review for a permit. Same to be in accordance with Section 7 (a) application and permits, Pennsylvania Solid Waste Management - "Act 241."

Statement of Bidder's Qualifications

18. Name, address, phone number, and contact person at surety company who will provide bonding for this contract:

Anderson & Catania - Rich Anderson - (302)762-7599

19. Name, address, phone number, and contact person at insurance company who will provide insurance coverage for this contract:

Safegard Group - Vicki Murray - 610-892-6834

20. The undersigned hereby authorizes any person, firm or corporation to furnish any information requested by the City of Reading in verification of the recitals comprising this Statement of Bidder's Qualifications.

DATED at 416 Stump Road this 10th day of November, 20 21.

Brendan Stanton, Inc. dba
BSI Electrical Contractors

(NAME OF BIDDER)

BY: 

Brendan Stanton

TITLE: President/Secretary



STATEMENT OF BIDDER'S QUALIFICATIONS

11/10/21

TO: City of Reading

Project: Reading Public Library Electrical & Mechanical Upgrades

6. - Projects Now in Progress:

<i>Buckingham Township</i>	\$1,118,000.00
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<i>Water and Wastewater Department Facility</i>	<u>0.00</u>
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Owner: Buckingham Township	\$1,118,000.00
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4613 Hughesian Drive

Buckingham, PA 18912

Type: Electrical Construction	
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Engineer: KCBA Architects	
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8 E Broad Street

Hatfield, PA

Contact: Vanessa Nedrick	(610) 940-1050
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Completion: November 2021	
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<i>PENNDOT</i>	\$1,679,900.00
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<i>District 6-0 Engineering Office Back Up Generator</i>	<u>0.00</u>
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Owner: Department of General Services	\$1,679,900.00
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9999 Hamilton Blvd

Breinigsville, PA 18031

Type: Electrical Construction	
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Contact: Nathan Davion	
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Completion: June 2022	
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<i>PENNDOT</i>	\$379,000.00
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<i>District 6-0 Parking Garage</i>	<u>0.00</u>
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Owner: Department of General Services	\$379,000.00
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9999 Hamilton Blvd

Breinigsville, PA 18031

Type: Electrical Construction	
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CM: Heim Construction	
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Contact: Michael Wright	
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Completion: June 2022	
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Bid For: Reading Public Library Electrical & Mechanical Upgrades

Attachment to Contractor's Qualification

11/10/21

Page 2

PENNDOT **\$5,434,900.00**

District 6-0 - RTMC **0.00**

Owner: Department of General Services **\$5,434,900.00**

9999 Hamilton Blvd
Breinigsville, PA 18031

Type: Electrical Construction

CM: Heim Construction

Contact: Michael Wright

Completion: June 2022

East Rockhill Township **\$147,000.00**

Sewage Pumping Station Replacement **0.00**

Owner: East Rockhill Township **\$147,000.00**

1622 N Ridge Road
Perkasie, PA 18944

Type: Electrical Construction

Engineer: CKS Engineers
4259 W Swamp Rd #410
Doylestown, PA 18901

Contact: JJ Kelso (215) 340-0600

Completion: February 2022

City of Reading **\$13,073,700.00**

Fritz Island WWTP **334,339.00**

Owner: City of Reading **\$13,408,039.00**

815 Washington Street
Reading, PA 19601

Type: Electrical Construction

Engineer: Hazen and Sawyer Architects
498 Seventh Avenue, 11th Floor
New York, NY 10018

Contact: Ed Daher, P.E., CCM (212) 539-7000

Completion: December 2021

Lehigh County Authority **\$383,480.00**

Kohler Tract Pumping Station **6,965.00**

Owner: Lehigh County Authority **\$390,445.00**

1053 Spruce Road
Wescosville, PA 18106

Type: Electrical Construction

Engineer: Johnson, Mirmiran & Thompson, Inc
7248 Tilghman Street
Allentown, PA 18106

Contact: Christopher Brendza

Completion: November 2021

Bid For: Reading Public Library Electrical & Mechanical Upgrades

Attachment to Contractor's Qualification

11/10/21

Page 3

Morrisville Municipal Authority **\$392,680.00**

Service Water Distribution Pump Relocation **0.00**

Owner: Morrisville Municipal Authority **\$392,680.00**

35 Union St,

Morrisville, PA 19067

Type: Electrical Construction

Engineer: Pennonie

1900 Market Street

Philadelphia, PA 19103

Contact: Robert Campbell

Completion: June 2022

Norristown Municipal Waste Authority **\$1,924,455.00**

Wastewater Treatment Plant Phase 1 Improvements **27,979.00**

Owner: Norristown Municipal Waste Authority **\$1,952,434.00**

25 E Marshall St,

Norristown, PA 19401

Type: Electrical Construction

Engineer: Herbert, Rowland & Grubric, Inc

369 E Park Drive

Harrisburg, PA 17111

Contact: Joshua Fox (717) 564-1121

Completion: December 2022

Lehigh County Authority **\$524,500.00**

Sands Spring WWTP Upgrades **15,000.00**

Owner: Lehigh County Authority **\$539,500.00**

1053 Spruce Road

Wescosville, PA 18106

Type: Electrical Construction

Engineer: Entech Engineer

201 Penn Street

Reading, PA 19603

Completion: December 2021

City of Reading **\$2,749,000.00**

6th & Canal Pumping Station **0.00**

Owner: City of Reading **\$2,749,000.00**

815 Washington Street

Reading, PA 19601

Type: Electrical Construction

Engineer: RK&K

3501 Concord Road

York, PA 17402

Completion: May 2022

Bid For: Reading Public Library Electrical & Mechanical Upgrades

Attachment to Contractor's Qualification

11/10/21

Page 4

Upper Moreland Hatboro Joint Sewer Authority **\$364,200.00**

Influent Bypass/High Flow Pump Station Project **0.00**

Owner: UMHJSA **\$364,200.00**

2875 Terwood Road
Willow Grove, PA 19090

Type: Electrical Construction

Engineer: Environmental Engineers & Management Associates
140 Clemens Rd #101,
Harleysville, PA 19438

Contact: Anthony Price (215) 368-3375

Completion: October 2021

Upper Moreland Hatboro Joint Sewer Authority **\$1,149,00.00**

Influent Pump Station Project **0.00**

Owner: UMHJSA **\$1,149,000.00**

2875 Terwood Road
Willow Grove, PA 19090

Type: Electrical Construction

Engineer: Environmental Engineers & Management Associates
140 Clemens Rd #101,
Harleysville, PA 19438

Contact: Anthony Price (215) 368-3375

Completion: February 2022

Upper Moreland Hatboro Joint Sewer Authority **\$174,900.00**

MCC-7 Replacement **0.00**

Owner: UMHJSA **\$174,900.00**

2875 Terwood Road
Willow Grove, PA 19090

Type: Electrical Construction

Engineer: Environmental Engineers & Management Associates
140 Clemens Rd #101,
Harleysville, PA 19438

Contact: Anthony Price (215) 368-3375

Completion: October 2021

West Goshen Township **\$769,000.00**

WWTP Phase II Improvements **31,425.00**

Owner: West Goshen Township **\$800,425.00**

1025 Paoli Pike
West Chester, PA 19380

Type: Electrical Construction

Engineer: Herbert, Rowland & Grubic, Inc
369 East Park Drive
Harrisburg, PA 17111

Contact: Joshua Fox (717) 564-1121

Completion: December 2021

Bid For: Reading Public Library Electrical & Mechanical Upgrades

Attachment to Contractor's Qualification

11/10/21

Page 5

<i>Whitemarsh Township Authority</i>	\$599,000.00
<i>Sludge Dewatering Facilities</i>	<u>0.00</u>
Owner: Whitemarsh Township Authority	\$321,830.00
462 Germantown Pike	
Lafayette Hill, PA 19444	
Type: Electrical Construction	
Engineer: Carroll Engineering Corporation	
949 Easton Road	
Warrington, PA 18976	
Contact: Allen Mason (215) 343-5700	
Completion: August 2022	

9. -Projects Completed in the Past Five (5) Years:

<i>Upper Gwynedd Township Wastewater Treatment Plant</i>	\$777,000.00
<i>Flow Diversion Pump Stations</i>	<u>0.00</u>
Owner: Upper Gwynedd Township	\$777,000.00
PO Box 1	
West Point, PA 19486	
Type: Electrical Construction	
Engineer: Environmental Engineering	
140 Clemens Road	
Harleysville, PA 19438	
Contact: Bill Brown, PE (215) 368-3375	
Completion: September 2021	

<i>Lehigh County Authority</i>	\$395,000.00
<i>Buss Acres Well Station Improvements</i>	<u>0.00</u>
Owner: Lehigh County Authority	\$395,000.00
1053 Spruce Road	
Wescosville, PA 18106	
Type: Electrical Construction	
Engineer: Buchart Horn	
445 West Philadelphia Street	
York, PA 17401-3383	
Contact: Edward DiMond (717) 852-1400	
Completion: August 2021	

<i>Bath Borough Authority</i>	\$1,621,000.00
<i>BBA Treatment Plant Upgrades</i>	<u>91,008.00</u>
Owner: Bath Borough Authority	\$1,712,008.00
160 Mill Street	
Bath, PA 18014	
Type: Electrical Construction	
Engineer: Alfred Benesch & Co.	
400 One Norwegian Plaza	
Pottsville, PA 17901	
Completion: August 2021	

Bid For: Reading Public Library Electrical & Mechanical Upgrades

Attachment to Contractor's Qualification

11/10/21

Page 6

Easton Suburban Water Authority **\$163,945.00**

Supplemental Sodium Hydroxide Storage Project **0.00**

Owner: Easton Suburban Water Authority **\$163,945.00**

3700 Hartley Avenue

Easton, PA 18043

Type: Electrical Construction

Engineer: BCM Engineers

920 Germantown Pike

Plymouth Meeting, PA 19462

Contact: Michael Lewandowski (610) 313-3100

Completion: July 2021

Borough of Lansdale **\$3,049,900.00**

Utility Complex – Solar Array **0.00**

Owner: Borough of Lansdale **\$3,049,900.00**

1 Vine Street

Lansdale, PA 19446

Type: Electrical Construction

Engineer: Remington & Vernick Engineers

922 Fayette Street

Conshohocken, PA 19428

Contact: Owen Hyne (610) 940-1050

Completion: June 2021

City of Bethlehem **\$248,525.00**

WWTP Bar Screen & Detritor **70,231.00**

Owner: City of Bethlehem **\$318,756.00**

10 E Church Street

Bethlehem, PA 18018

Type: Electrical Construction

Engineer: SSM Group

1047 N Park Road

Reading, PA 19610

Contact: Amy Rohrbach (610) 865-7040

Completion: January 2021

Township of Bristol **\$87,430.00**

Bristol Pump Station – Portable Generator Connections **0.00**

Owner: Township of Bristol **\$87,430.00**

2501 Bath Road

Bristol, PA 19007

Type: Electrical Construction

Engineer: Remington & Vernick Engineers

922 Fayette Street

Conshohocken, PA 19428

Contact: Mark Marella (215) 368-5806

Completion: January 2021

Bid For: Reading Public Library Electrical & Mechanical Upgrades

Attachment to Contractor's Qualification

11/10/21

Page 7

Booster Pump Station **\$228,000.00**

Two Million Gallon Storage Tank **6,293.00**

Owner: Perkaie Regional Authority **\$234,293.00**

150 Ridge Road, Suite 1

Sellersville, PA 18960

Type: Electrical Construction

Engineer: Anderson Engineering

150 Ridge Road

Sellersville, PA

Contact: Pete Anderson (215) 257-5711

Completion: February 2021

Upper Moreland Hatboro Joint Sewer Authority **\$81,675.00**

Odor Control Improvements Project **0.00**

Owner: UMHJSA **\$81,675.00**

2875 Terwood Road

Willow Grove, PA 19090

Type: Electrical Construction

GC: LB Industries

2290 Wassergrass Road

Hellertown, PA 18055

Completion: August 2020

Chalfont New Britain Joint Sewer Authority **\$244,255.00**

Bisolids Dryer **0.00**

Owner: Chalfont New Britain Joint Sewer Authority

1645 Upper State Road

\$244,255.00

Doylestown, PA 18901-2666

Engineer: CKS Engineers

88 South Main Street

Doylestown, PA 18901

Contact: JJ Kelso (215) 340-0600

Completion: August 2020

Valley Forge Sewer Authority **\$312,000.00**

WWTP Headworks Improvements **0.00**

Owner: Valley Forge Sewer Authority **\$312,000.00**

333 Pawlings Rd,

Phoenixville, PA 19460

Type: Electrical Construction

Engineer: Buchart Horn

445 W Philadelphia Street

York, PA 17405

Contact: Edward DiMond (717) 852-1400

Completion: June 2020

Bid For: Reading Public Library Electrical & Mechanical Upgrades

Attachment to Contractor's Qualification

11/10/21

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Horsham Water and Sewer Authority **\$418,000.00**

PFC Treatment Systems – Group 2 **153,239.00**

Owner: Horsham Water & Sewer Authority **\$571,239.00**

617 Horsham Road

Horsham, PA 19044

Type: Electrical Construction

Engineer: Gilmore & Associates

65 E Butler Pike

New Britain, PA

Contact: Matt Bailor (215) 345-4500

Completion: December 2019

Upper Merion Sanitary & Stormwater Authority **\$264,250.00**

Flint Hill & Swedesburg Pump Stations EM Generators **0.00**

Owner: Upper Merion Township **\$264,250.00**

175 West Valley Forge Road

King of Prussia, PA 19460

Type: Electrical Construction

Engineer: Arro Engineering

649 N Lewis Road

Limerick, PA 19468

Contact: William Bohner, PE (610) 495-0303

Completion: December 2019

Township of Abington **\$126,100.00**

Influent Pump Station Generator **36,900.00**

Owner: Township of Abington **\$163,000.00**

1176 Old York Road

Abington, PA 19001

Type: Electrical Construction

Engineer: Tangible, LLC.

301 Oxford Valley Rd., Suite 1604

Yardley, PA 19067

Contact: Eric Cunningham (215) 369-9345

Completion: December 2019

Upper Moreland Hatboro Joint Sewer Authority **\$286,900.00**

Utility Water Pump Station Upgrade **0.00**

Owner: UMHJSA **\$286,900.00**

2875 Terwood Road

Willow Grove, PA 19090

Type: Electrical Construction

Engineer: Environmental Engineers & Management Associates

140 Clemens Rd #101,

Harleysville, PA 19438

Contact: Anthony Price (215) 368-3375

Completion: November 2019

Bid For: Reading Public Library Electrical & Mechanical Upgrades

Attachment to Contractor's Qualification

11/10/21

Page 9

Warrington Township **\$213,054.00**

Upper Area Booster Station Improvements **2,500.00**

Owner: Warrington Township **\$215,554.00**

829 Easton Road

Warrington, PA

Engineer: CKS Engineers

88 South Main Street

Doylestown, PA 18901

Contact: JJ Kelso (215) 340-0600

Completion: October 2019

Upper Gwynedd Township Wastewater Treatment Plant **\$259,020.00**

PLC Replacement Project **0.00**

Owner: Upper Gwynedd Township **\$259,020.00**

PO Box 1

West Point, PA 19486

Type: Electrical Construction

Engineer: Environmental Engineering

140 Clemens Road

Harleysville, PA 19438

Contact: Bill Brown, PE (215) 368-3375

Completion: September 2019

Upper Merion Township **\$199,750.00**

Highway Facility Generator **(10,750.00)**

Owner: Upper Merion Township **\$189,000.00**

175 West Valley Forge Road

King of Prussia, PA 19460

Type: Electrical Construction

Engineer: Arro Engineering

649 N Lewis Road

Limerick, PA 19468

Contact: William Bohner, PE (610) 495-0303

Completion: August 2019

Township of Lower Merion **\$108,764.00**

Cynwyd Pump Station Electrical Service Replacement **(25,201.00)**

Owner: Township of Lower Merion **\$83,563.00**

75 E Lancaster Avenue

Ardmore, PA 19003

Type: Electrical Construction

Engineer: Pennoni Associates

1 Drexel Plaza

3001 Market St.

Philadelphia, PA 19104

Contact: Steve Seacrist (215) 222-3000

Completion: May 2019

Bid For: Reading Public Library Electrical & Mechanical Upgrades

Attachment to Contractor's Qualification

11/10/21

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Central Bucks School District **\$59,900.00**

New 35kV Electrical Service **0.00**

Owner: Central Bucks School District **\$59,900.00**

320 West Swamp Road

Doylestown, PA 18901

Engineer: Reynolds Construction Engineering

3300 N 3rd Street

Harrisburg, PA 17110

Contact: Joe White (717) 238-5737

Completion: May 2019

North Penn Water Authority **\$138,200.00**

Wells NP-5 & NP-17 Electrical Upgrades **0.00**

Owner: North Penn Water Authority **\$138,200.00**

300 Forty Foot Road

Lansdale, PA 19446

Type: Electrical Construction

Engineer: Instrumentation, Control & Energy Engineering

PO Box 551

Skippack, PA 19474

Contact: Joe Guango (610) 584-6714

Completion: May 2019

Upper Moreland Hatboro Joint Sewer Authority **\$97,522.00**

Cloth Wiring Replacement **0.00**

Owner: UMHJSA **\$97,522.00**

2875 Terwood Road

Willow Grove, PA 19090

Type: Electrical Construction

Engineer: Burns Engineering, Inc.

2001 Market Street, Suite 600

Philadelphia, PA 19103

Contact: Barry Bailey, PE (215) 979-7700

Completion: March 2019

Upper Moreland Hatboro Joint Sewer Authority **\$279,000.00**

Motor Control Center Replacement **0.00**

Owner: UMHJSA **\$279,000.00**

2875 Terwood Road

Willow Grove, PA 19090

Type: Electrical Construction

Engineer: Burns Engineering, Inc.

2001 Market Street, Suite 600

Philadelphia, PA 19103

Contact: Barry Bailey, PE (215) 979-7700

Completion: March 2019

Bid For: Reading Public Library Electrical & Mechanical Upgrades

Attachment to Contractor's Qualification

11/10/21

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Buckingham Village Wastewater Treatment Plant **\$372,000.00**

2017 Plant Upgrades **0.00**

Owner: Buckingham Village WWTP **\$372,000.00**

2380 Durham Road

Buckingham, PA 18912

Type: Electrical Construction

Engineer: Castle Valley Consultants

10 Beulah Road

New Britain, PA 18901

Contact: Megan Kawamoto (215) 348-8257

Completion: March 2019

Forest Park Water **\$553,800.00**

Membrane Filtration System Improvement Project **0.00**

Owner: North Penn & North Wales Water & Sewer **\$553,800.00**

144 Park Avenue

Chalfont, PA 18914

Type: Electrical Construction

Engineer: Gannett Fleming

202 Senate Avenue

Camp Hill, PA 17011

Contact: Timothy Glessner (717) 763-7211

Completion: November 2018

Chalfont New Britain Joint Sewer Authority **\$1,723,000.00**

Wastewater Treatment Plant Expansion & Upgrade Phase III

Owner: Chalfont New Britain Joint Sewer Authority **31,374.00**

1645 Upper State Road

\$1,754,374.00

Doylestown, PA 18901-2666

Engineer: CKS Engineers

88 South Main Street

Doylestown, PA 18901

Contact: JJ Kelso (215) 340-0600

Completion: October 2018

Towamencin Municipal Authority **\$186,800.00**

34.5KV/480V Transformer Replacement **0.00**

Owner: Towamencin Municipal Authority **\$186,800.00**

2225 Kriebel Road

Lansdale, PA 19446

Type: Electrical Construction

Engineer: Bursich Associates

706 Lakeside Drive

Southampton, PA 18966

Contact: Dick Smith (267) 566-3966

Completion: August 2018

Bid For: Reading Public Library Electrical & Mechanical Upgrades

Attachment to Contractor's Qualification

11/10/21

Page 12

County of Bucks **\$789,500.00**

Correctional Facility Generator **0.00**

Owner: County of Bucks **\$789,500.00**

55 E. Court Street
Doylestown, PA 18901

Type: Electrical Construction

Engineer: Holstein White, Inc.
210 East Street Road, Suite 2D
Feasterville, PA 19053

Contact: Martin Blasko, PE (215) 322-7711

Completion: June 2018

Warminster Municipal **\$47,500.00**

***One Filter Building & Installation of One Activated
Carbon Filtration System*** **0.00**

Owner: Warminster Municipal Authority **\$47,500.00**

415 Gibson Avenue
Horsham, PA 19044

Type: Electrical Construction

Engineer: CKS Engineers
88 S Main Street
Doylestown, PA

Contact: JJ Kelso (215) 340-0600

Completion: June 2018

Valley Forge Sewer Authority **\$189,500.00**

Substation Transformer Replacement **0.00**

Owner: Valley Forge Sewer Authority **\$189,500.00**

333 Pawlings Rd,
Phoenixville, PA 19460

Type: Electrical Construction

Engineer: Burns Engineering
2001 Market Street, Suite 600
Philadelphia, PA 19103

Contact: Barry Bailey, PE (215) 979-7700

Completion: May 2018

Reading Area Water Authority **\$596,000.00**

Water Filtration Plant Electrical Upgrade **0.00**

Owner: Reading Area Water Authority **\$596,000.00**

1801 Kutztown Road
Reading, PA 19604

Type: Electrical Construction

Engineer: Cardno/BCM Engineering
920 Germantown Pike
Plymouth Meeting, PA

Contact: Alan Wong (610) 313-3100

Completion: December 2017

Bid For: Reading Public Library Electrical & Mechanical Upgrades

Attachment to Contractor's Qualification

11/10/21

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Upper Merion Township **\$268,800.00**

Matsunk WPCC – Electrical Substation Project **0.00**

Owner: Upper Merion Township **\$268,800.00**

175 West Valley Forge Road

King of Prussia, PA 19460

Type: Electrical Construction

Engineer: Arro Engineering

649 N Lewis Road

Limerick, PA 19468

Contact: William Bohner, PE (610) 495-0303

Completion: December 2017

SCI Phoenix – Graterford Prison **\$8,773,000.00**

Buildings K, L & M - Support Building &

Industries East and West **1,076,036.80**

Owner: Graterford Prison **\$9,849,038.80**

Piggery Road

Skippack, PA

GC: Walsh/Heery Joint Venture

Piggery Road

Skippack, PA

Danny Taylor (484) 973-6443

Completion: December 2017

SCI Phoenix – Graterford Prison **\$6,564,000.00**

Cell Blocks A, B, L & M - Activities East and West,

Guard Towers and Sallyport, Headworks **478,434.00**

Owner: Graterford Prison **\$7,042,434.00**

Piggery Road

Skippack, PA

GC: Walsh/Heery Joint Venture

Piggery Road

Skippack, PA

Danny Taylor (484) 973-6443

Completion: December 2017

12. - Construction Experience of Principal Individuals

Brendan Stanton, President/Secretary, established the business in 1977. BSI has grown to encompass all aspects of the electrical construction field, including heavy industrial projects, technical electronic automation projects, and public works projects, in addition to excavation, concrete, rigging and general construction projects. The majority of our work force has been with the organization for 10-plus years. The continuity enhances the commitment we have of high quality performance our customers have come to know and trust over the years.

Bid For: Reading Public Library Electrical & Mechanical Upgrades

Attachment to Contractor's Qualification

11/10/21

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Key personnel are currently involved in various construction and renovation projects. Most foreman level mechanics have several years' experience in job supervision for a variety of construction projects. If awarded the contract, the manpower will be as such that key personnel would be rearranged from projects nearing completion in order to properly expedite and perform the necessary requirements of this project.

<u>Personnel</u>	<u>Title</u>	<u>Years' Experience</u>	<u>Years @ BSI</u>
Brendan Stanton	President-Owner-Manager	46	44
Robert Miller	Project Manager/ Estimator	37	22
Jeff Tranauskas	Project Manager/ Estimator	38	26
Robert Taylor, PE	Project Manager/Engineer	27	19
Chris Stanton, PE	Project Manager/Engineer	17	12
Michael McCaughey	Project Manager/EIT	7	7
Paul Spector	Site Superintendent/Project Mgr	37	34
Eric Fluhrer	Site Superintendent	35	32
Andrew Coyne	Site Superintendent	25	25



Road Equipment

- | | |
|---|--|
| 1 Western Star Tractor w/ Landoll Trailer
1 International w/ 23-ton Terex Crane
1 International w/ 60' Bucket
2 Ford 650 w/ 45 Bucket
1 Ford Super Duty Dump Truck
1 Peterbilt Dump Truck
1 International Dump Truck
1 Marmon Roll off | 1 Freightliner Roll off
1 Freight liner Derrick Digger w/ Pole Carrier
1 12' Isuzu Box Truck w/ lift gate
1 Ford Stake Body
1 Grove ATS 40 Ton Crane
1 Ford Fuel Tanker
Misc. Work Vans & Pick-up Trucks |
|---|--|

Off-Road/Excavation Equipment

- | | |
|--|--|
| 1 CAT 312 Excavator
1 CAT 420 D Backhoe
1 Ford 2110 Backhoe
1 JD 240 Skid Steer
1 CAT DC 3 Bulldozer
2 CAT 420E Backhoe
2 Ditch witch trencher
1 Bulldog trench roller
1 Ditch witch soft dig
1 I/R Excavator
2 All terrain fork truck
5 Rough Terrain Fork Lifts - 6000lbs to 10000lbs
1 Fork Lift - 18000lbs | 1 All terrain 14-ton grove crane
1 Vibratory Plate Tamper
1 Daewoo Rubber Tire Excavator
1 Daewoo Rubber Tire Loader
1 Bomag Roller
1 Sullivan Tow Behind Compressor
1 Corecut Concrete Saw
2 I/R Airsource Compressors
1 Bomag Trench Roller
1 Bobcat Skid Steer
1 CAT Skid Steer
Breaker and Compactor Attachments for
Backhoes and Excavators |
|--|--|

Construction Equipment

- | | |
|--|--|
| Air Compressors
Office trailers
Storage Trailers
Scissor Lifts - 15' thru 33'
Aerial Lifts 33' thru 68'
Condux cable glider
Dranetz power analyzer
MSE Comstar radio detection kit
Foot compactor/tamper
Portable 2-way radios
Floor mounted drill press
Power tray pulling sheaves kit
High potential test equipment
2-8KW Portable Generators | Crimpers & Cutters
Greenlee rigid pipe benders
Greenlee wire pullers
Bench threading machines
Wire labeling machines
Underground utilities detector
280 CFM air compressor & hammer
Nail guns & compressors
Portable gas welders
Portable rebar cutter
Floor mounted band saw
Core drilling machines
Scaffolding |
|--|--|

Generators, Transformers & Light Towers

1 Elliot Magnetek 125QD Gen Set	1 CAT XQ-400 Generator
1 CAT XQ225 Gen Set	1 Terex 120KVA / 95KW Generator
1 Onan 50KW Generator	1 Terex 70KVA / 55KW Generator
1 Central Detroit Diesel 1000KW Gen Set	2 Magnum MLG 25 KVA Generator
1 Cat XQ-1750 Generator	1 Amida Site Lights Tow Behind Light Tower
1 I/R G115 Generator	1 Wacker LT4 Tow Behind Light Tower
1 I/R G11ME Generator	2 I/R Light Source Light Tower
1 I/R G575 Generator	1 Alstom 200KVA Pad Mount Transformer
1 Loadtec 1205KW Loadbank	1 500 KVA Pad Mount Transformer

All Equipment is Owned and Operated
by BSI - Electrical Contractors

Brendan Stanton

Brendan Stanton - President/Secretary

Dated: November 10, 2021



READING PUBLIC LIBRARY ELECTRICAL & MECHANICAL UPGRADES

FOR:

DEPARTMENT OF PUBLIC WORKS, CITY OF READING

BERKS COUNTY, CITY OF READING, PENNSYLVANIA

MAY 2021



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END OF SECTION 00 01 10

SECTION 03 30 53**CONCRETE FOR UTILITY CONSTRUCTION****PART 1 GENERAL****1.1 DESCRIPTION**

- A. The Work of this section includes, but is not limited to:
1. Cast-in-place Cement Concrete Construction

1.2 REFERENCES

- A. Pennsylvania Department of Transportation (PennDOT): Publication 408 Specifications.
- B. American Society for Testing and Materials (ASTM):
1. ASTM A615 - Deformed and Plain Billet - Steel Bars for Concrete Reinforcement
 2. ASTM C31 - Methods of Making and Curing Concrete Test Specimens in the Field
 3. ASTM C39 - Test Method for Compressive Strength of Cylindrical Concrete Specimens
 4. ASTM C42 - Methods of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
 5. ASTM C94 - Ready Mixed Concrete
 6. ASTM C143 - Test Method for Slump of Portland Cement Concrete
 7. ASTM C172 - Method of Sampling Fresh Concrete
 8. ASTM C173 - Test Method for Air Content of Freshly Mixed Concrete - Volumetric Method
 9. ASTM C231 - Test Method for Air Content of Freshly Mixed Concrete - Pressure Method

1.3 SUBMITTALS

- A. Submit certification from the concrete producer attesting that the cement concrete conforms to the State Specifications for the class of concrete being used.
- B. Submit certified results of compressive strength tests performed by an independent testing laboratory.
- C. Submit detailed shop drawings of reinforcing steel.

PART 2 PRODUCTS**2.1 CEMENT CONCRETE**

- A. Ready-mixed, conforming to Section 704, cement concrete, Pub. 408 Specifications.
- B. Requirements for State approved batch plants, design computations and plant inspection shall not apply; the acceptability of concrete will be based on conformance with the Cement Concrete Criteria specified below and the results of the specified tests.
- C. Cement Concrete Criteria:
1. Class A:
 - a. 28-day compressive strength: 3300 psi
 - b. Slump: 1 to 3 inches
 - c. Air content: 5% ± 1%
 2. Class C:
 - a. 28-day compressive strength: 2000 psi
 - b. Slump: 2 to 6 inches
 - c. Air content: 5% ± 1%
 3. High Early Strength:
 - a. 3-day compressive strength: 3000 psi

- b. Slump: 1 to 3 inches
- 4. Cement Factor and Maximum Water-Cement Ratio conforming to Table A, Section 704.1(b), Pub. 408 Specifications.

2.2 REINFORCEMENT STEEL

- A. Reinforcement Bars:
 - 1. New billet-steel bars conforming to ASTM A615.
 - 2. Deformed, Grade 60.
- B. Steel Wire Fabric: Conforming to Section 709.3, Pub. 408 Specifications.
- C. Steel Wire Fabric for Concrete Sidewalks: Reinforce sidewalks with 6 inch by 6 inch - W2.6 x W2.6 welded wire fabric.

PART 3 EXECUTION

3.1 GENERAL

- A. Comply with applicable paragraphs of Section 1001, Pub. 408 Specifications for construction requirements including formwork, curing, protection and finishing of cement concrete.
- B. Proper grade markers or stakes shall be used by Contractor to establish grades for sidewalks.

3.2 CONSTRUCTION

- A. Construct cast-in-place sidewalks and miscellaneous reinforced structures of Class A concrete; Class A concrete shall be central-plant-mixed.
- B. Construct miscellaneous mass concrete of Class C concrete; Class C concrete may be from a mobile cement concrete plant or truck-mixed.
- C. Concrete Sidewalks and Pads:
 - 1. Sidewalks and pads shall be Class A air entrained concrete
 - a. Sidewalk slabs thickness to match existing.
 - b. Pads of thickness indicated on the Contract Drawings.
 - 2. Subgrade shall be properly prepared and thoroughly wetted before placing concrete.
 - 3. Unless otherwise indicated:
 - a. Construct sidewalks in separate slabs 20 feet in length except for closures; slabs separated by 1/4 inch thick transverse expansion joints.
 - b. Between expansion joints, divide slabs into blocks five feet in length by scoring transversely.
 - c. Slabs more than five feet in width, score longitudinally in center.
 - d. Scoring shall extend at least a third of slab thickness into slab.
- D. Provide spacers, chairs, bolsters, ties and other devices for properly placing, spacing, supporting and fastening reinforcement in place.
- E. Place concrete utilizing all possible care to prevent displacement of pipe or fittings; return displaced pipe or fittings to line and grade immediately.
- F. Do not backfill structures until concrete has achieved its initial set, forms are removed, and concrete work is inspected by the Engineer.
- G. Perform backfilling and compaction as specified in Section 31 23 17 - Trenching, Backfilling and Compacting.

3.3 FINISHING

- A. Integral Finishes: Obtain finishes on concrete slabs without applying separate topping coat, as follows:
1. Broom Finish: Draw stiff broom over previously floated finish, to obtain non-slip finish, on exterior sidewalks, ramps, stairs, pads and similar locations.

3.4 FIELD TESTS OF CONCRETE DURING CONSTRUCTION

- A. Perform compressive strength, slump and air content tests for each 50 cubic yards of each class of structural concrete placed, or fraction thereof.
- B. Testing is not required for non-structural applications.
- C. Retain an independent testing laboratory to test cylinders.
- D. Keep a slump cone and an air meter in close proximity to all concrete placements.
- E. Sample concrete in accordance with ASTM C172.
- F. Determine slump in accordance with ASTM C143.
- G. Determine air content in accordance with ASTM C231 or ASTM C173 as applicable.
- H. Test Cylinders:
1. Cast at least 5 cylindrical test specimens for each batch.
 2. Test two cylinders at 7 days; test two cylinders at 28 days.
 3. Hold the remaining cylinder in reserve for testing in the event that any of the other cylinders are damaged prior to testing.
 4. Prepare and cure test cylinders in accordance with ASTM C31.
 5. Determine concrete compressive strength in accordance with ASTM C39.
 6. Compute and evaluate in accordance with ASTM C94.
- I. If test cylinders fail to meet compressive strength requirements, the Engineer may require additional core tests in accordance with ASTM C42 at the expense of the Contractor.

END OF SECTION 03 30 53

SECTION 07 84 00**FIRESTOPPING****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Firestopping of joints and penetrations in fire-resistance-rated and smoke-resistant assemblies, whether indicated on drawings or not.

1.2 REFERENCE STANDARDS

- A. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2015.
- B. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Fire Stops; 2013a.
- C. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi; 2015.
- D. ITS (DIR) - Directory of Listed Products; current edition.
- E. FM (AG) - FM Approval Guide; current edition.
- F. SCAQMD 1168 - South Coast Air Quality Management District Rule No.1168; current edition.
- G. UL 1479 - Standard for Fire Tests of Penetration Firestops; Current Edition, Including All Revisions.
- H. UL (DIR) - Online Certifications Directory; current listings at database.ul.com.
- I. UL (FRD) - Fire Resistance Directory; current edition.

1.3 SUBMITTALS

- A. Schedule of Firestopping: List each type of penetration and fire rating of the penetrated assembly.
- B. Product Data: Provide data on product characteristics, performance ratings, and limitations.
- C. Sustainable Design Submittal: Submit VOC content documentation for nonpreformed materials.
- D. Manufacturer's Installation Instructions: Indicate preparation and installation instructions.
- E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- F. Manufacturer's qualification statement.
- G. Installer's qualification statement.

1.4 QUALITY ASSURANCE

- A. Fire Testing: Provide firestopping assemblies of designs that provide the scheduled fire ratings when tested in accordance with methods indicated.
 - 1. Listing in UL (FRD), FM (AG), or ITS (DIR) will be considered as constituting an acceptable test report.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Installer Qualifications: Company specializing in performing the work of this section and:

1. Verification of minimum three years documented experience installing work of this type.

1.5 MOCK-UP

- A. Install one firestopping assembly representative of each fire rating design required on project.
 1. Where one design may be used for different penetrating items or in different wall constructions, install one assembly for each different combination.
- B. Obtain approval of authorities having jurisdiction (AHJ) before proceeding.
- C. If accepted, mock-up will represent minimum standard for this work.
- D. If accepted, mock-up may remain as part of this work. Remove and replace mock-ups not accepted.

1.6 FIELD CONDITIONS

- A. Contractors shall coordinate a meeting with authorities having jurisdiction (AHJ) and walk the project site, reviewing scope of work and determine where firestopping shall be required and what rating the firestopping is required to meet, the following shall be a minimum:
 1. New construction passing through existing floor construction, provide 2 hour fire rating.
 2. New construction passing through existing corridor wall construction; provide 1 hour fire rating.
- B. Comply with firestopping manufacturer's recommendations for temperature and conditions during and after installation; maintain minimum temperature before, during, and for three days after installation of materials
- C. Provide ventilation in areas where solvent-cured materials are being installed.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Firestopping Manufacturers:
 1. 3M Fire Protection Products: www.3m.com/firestop/#sle.
 2. Hilti, Inc: www.us.hilti.com/#sle.
 3. Nelson FireStop Products: www.nelsonfirestop.com/#sle.
 4. Specified Technologies Inc: www.stfirestop.com/#sle.

2.2 MATERIALS

- A. Firestopping Materials: Any materials meeting requirements.
- B. Volatile Organic Compound (VOC) Content: Provide products having VOC content lower than that required by SCAQMD 1168.
- C. Mold and Mildew Resistance: Provide firestopping materials with mold and mildew resistance rating of zero(0) in accordance with ASTM G21.
- D. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Provide type of materials as required for tested firestopping assembly.

2.3 FIRESTOPPING ASSEMBLY REQUIREMENTS

- A. Through Penetration Firestopping: Use system that has been tested according to ASTM E814 to have fire resistance F Rating equal to required fire rating of penetrated assembly.
 1. Listing by FM (AG), ITS (DIR), UL (DIR), or UL (FRD) in their certification directories will be considered evidence of successful testing.

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2.4 FIRESTOPPING PENETRATIONS THROUGH GYPSUM BOARD WALLS**2.5 FIRESTOPPING SYSTEMS**

- A. Firestopping: Any material meeting requirements.
 - 1. Fire Ratings: Use system that is listed by FM (AG), ITS (DIR), or UL (FRD) and tested in accordance with ASTM E814, ASTM E119, or UL 1479 with F Rating equal to fire rating of penetrated assembly and minimum T Rating Equal to F Rating and in compliance with other specified requirements.
- B. Firestopping at Uninsulated Metallic Pipe and Conduit Penetrations, of diameter 4 inches or less: Caulk or putty.
- C. Firestopping at Combustible Pipe and Conduit Penetrations, of diameter 4 inches or less: Any material meeting requirements.
- D. Firestopping at Cable Tray Penetrations: Any material meeting requirements.
- E. Firestopping at Cable Penetrations, not in Conduit or Cable Tray: Caulk or putty.

PART 3 EXECUTION**3.1 EXAMINATION**

- A. Verify openings are ready to receive the work of this section.

3.2 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other materials that could adversely affect bond of firestopping material.
- B. Remove incompatible materials that could adversely affect bond.
- C. Install backing materials to prevent liquid material from leakage.

3.3 INSTALLATION

- A. Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.
- B. Do not cover installed firestopping until inspected by authorities having jurisdiction.
- C. Install labeling required by code.

3.4 FIELD QUALITY CONTROL

- A. Repair or replace penetration firestopping and joints at locations where inspection results indicate firestopping or joints do not meet specified requirements.

3.5 CLEANING

- A. Clean adjacent surfaces of firestopping materials.

3.6 PROTECTION

- A. Protect adjacent surfaces from damage by material installation.

END OF SECTION 07 84 00

SECTION 23 05 00**COMMON WORK RESULTS FOR HVAC****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Mechanical / HVAC work shall include all final connections and flexible connections to the mechanical / HVAC system and to related equipment by others, as well as, connections to external systems and mechanical / HVAC systems (site connections, make-up water connections, indirect waste connections, etc.).

1.2 REFERENCE STANDARDS

- A. ASHRAE 15 - American Society of Heating Refrigeration and Air-Conditioning Engineers.
- B. ASHRAE 34 - American Society of Heating Refrigeration and Air-Conditioning Engineers.
- C. ASME (BPV) - Boiler and Pressure Vessel Code; American Society of Mechanical Engineers; 2013.
- D. NFPA 72 - National Electric Code, National Fire Protection Association.
- E. UL (FPED) - Fire Protection Equipment Directory; Underwriters Laboratories Inc.; current edition.

1.3 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's most current catalog data sheet for equipment indicating rough-in size, finish, and accessories. Manufacturer's data sheets on each item of equipment and device, shall be clearly marked up to identify the items, accessories and options to be used on the project.
- C. Coordination Drawings: Indication locations for products and resolve conflicts with other trades.
- D. Project Record Documents: Record actual installed locations of components and tag numbering.
- E. Operation and Maintenance Data: Include installation instructions and spare parts lists.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
 - 1. Submittal of documented experience, submitted upon request by Engineer.
- B. Installer Qualifications: Company specializing in performing work of the type specified this section.
 - 1. Minimum three years experience. Submittal of documented experience, submitted upon request by Engineer.
 - 2. Approved by manufacturer. Submittal of approval, submitted upon request by Engineer.
- C. Conform to UL, FM, and Warnock Hersey requirements.
- D. Products Requiring Electrical Connection: Listed and classified as suitable for the purpose specified and indicated.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store products in shipping containers, with labeling in place.
- B. Provide temporary protective coating on products.
- C. Provide temporary end caps and closures on duct, piping, equipment and fittings. Maintain in place until installation.
- D. Protect products from weather and construction traffic, dirt, water, chemical, and mechanical damage.
- E. Protect installed fixtures and equipment from damage by securing areas and by leaving factory packaging in place to protect equipment and fixtures and prevent use of equipment and fixtures.

1.6 CODES AND STANDARDS

- A. Work is subject to provisions of the International Building Code and has been designed to be in compliance with the Code. Design aspect of the Project shall not be altered regarding building envelope or selection of HVAC, service water heating systems and equipment. Supplemental data published by equipment and system manufacturers to substantiate energy conservation efficiencies throughout the Project shall be furnished at request of Engineer.
- B. Work shall meet requirements of the FM Global, National Fire Protection Association, all Federal, State, and Municipal authority's laws, rules and regulations applicable to the Work and public utilities having jurisdiction over systems specified herein.
- C. Boiler, Domestic Water Heater(s), Heating Equipment, and Pressure Vessels shall be constructed and tested in accordance with recommendations of the National Fire Protection Association, Pennsylvania Department of Labor and Industry - Boiler Inspection Division, and ASME BPV code.
 - 1. Equipment shall be stamped with the ASME symbol and National Board number and shall be inspected during construction by an inspector who has been commissioned by the Pennsylvania Department of Labor and Industry to perform such service. Equipment shall be prepared for initial inspection in accordance with Department of Labor and Industry regulations.
- D. Plumbing Work shall be installed in conformity with applicable portions of the ASME Plumbing Code, International Plumbing Code, Pennsylvania Department of Environmental Protection, State Plumbing Codes, and Local Ordinances and shall be approved as project progresses by local authority having jurisdiction.
- E. Contractor shall certify domestic water systems for compliance with Pennsylvania Plumbing System Lead Ban & Notification Act (No. 33-1989).
- F. Nothing in the Specifications shall be construed to permit deviation from requirements of any governing code(s).
- G. Fuel oil storage tank shall be installed in accordance with recommendations of the National Fire Protection Association and requirements of the Pennsylvania State Police - Fire Marshal's Division, Pennsylvania Department of Environmental Resources, Pennsylvania Storage Tank and Spill Prevention Act (no. 32-1989), and Code of Federal Regulation Title 40. Obtain required permits and inspections by respective agencies on behalf of Owner.
- H. Installation of all gas piping and gas burning equipment shall conform to recommendations of the American Gas Association, Factory Mutual Engineering Corporation, and local utility.
- I. The handling and use of CFC and HCFC refrigerants, whether leaking, venting, recovering, etc., shall be in accordance with US Environmental Protection Agency regulations CFR 58 FR 28660, ASHRAE

15-1994-Safety Code for Mechanical Refrigeration, and ANSI/ASHRAE 34-1997-Number Designation and Safety Classification of Refrigerants.

- J. Electrical Work shall meet requirements of the National Electrical Code and all Federal, State, and Municipal authority's laws, rules and regulations applicable to the Work.
- K. Where applicable, materials and equipment shall bear the label of approval of Underwriters Laboratories, Inc.
- L. Reference to codes and standards listed herein shall constitute minimum acceptable requirements. Where Drawings and Specification requirements exceed those of codes listed, Drawings and Specifications shall take precedence for Work of this Project.
- M. If Contractor, during the course of work, observes the existence of hazardous materials in the structure or on the project site, Contractor shall promptly notify Owner and Engineer. Contractor shall not perform any work pertinent to the hazardous material prior to receipt of special instructions from Owner. "Hazardous materials", for the purpose of this Specification, are defined as but not limited to asbestos, PCB's, petroleum, radioactive material, or any substance classified as hazardous waste substances.

1.7 COORDINATION - GENERAL

- A. Work shall be governed by requirements set forth in the conditions of the Contract.
- B. Provide all labor, materials, and equipment required by the Contract Documents necessary for completion of the Work.
- C. Bidders shall visit the project site to determine actual conditions which will be encountered in completing the work of this project.
- D. Drawings are generally indicative of work to be installed but may not indicate all bends, fittings, elbows, etc., required to meet conditions. Where items shown on the Drawings, or herein described, are not clearly understood, Bidders shall confer with Engineer.
- E. Coordinate Work of Division 23 with that of other trades so that work will be installed in the most direct manner and so that interference between piping, ducts, conduits, equipment, and architectural or structural features will be avoided. Work installed in an arbitrary manner without regard for work of other trades or equipment servicing requirements will be rejected in any situation where an undesirable condition or an unfair hardship for other trades, or Owner, results. Removal of installed work and installation of re-work will not be charge to owner, Work shall be at the expense of Contractor.
- F. Provide sufficient scaffolding and hoist or rig material and equipment into place, or arrange for rigging by others. In any case, rigging or hoisting for Work shall be at the expense of Contractor.
- G. Unless otherwise indicated on the Drawings, provide structural steel members as required for support of equipment and materials furnished under Division 23. Provide all hangers and supports, as specified, detailed, or in accordance with accepted industry standards.
- H. Equipment shall be installed in accordance with equipment manufacturer's installation instructions unless otherwise required by code or specific instructions. Obtain manufacturer's installation instructions prior to roughing-in.

1.8 COORDINATION - DUCT SMOKE DETECTORS

- A. Electrical Contractor will furnish duct smoke detector and accessories.
- B. Mechanical Contractor will install duct smoke detector duct mounted accessories.

- C. HVAC unit associated with duct smoke detector shall have combination motor start with contact for duct smoke detector / fire alarm shut down of unit.

1.9 COORDINATION - DISCONNECTS STARTERS AND VFD DRIVES.

- A. Disconnect starters and VFD drives shall be provided as indicated on the contract documents.
- B. Disconnects shall be suitable for use as an OSHA lockout/tagout disconnect when applied in accordance with part IV, Department of Labor OSHA 29 CFR part 1910.
- C. Disconnect handles can be padlocked in the "off" position with up to three padlocks. Switch mechanism can be directly padlocked in the "off" position when the door is open.

1.10 COORDINATION - EXISTING CONSTRUCTION

- A. Cut all openings required in existing construction for installation of equipment and material. Perform all cutting, patching, and refinishing as required to match surroundings, whether or not specifically noted on Drawings.
- B. Existing Ceilings: Remove existing ceiling tile where required for installation of mechanical Work. Replace ceiling tiles as Work is completed. All damaged or broken ceiling tile caused by Contractor's workers shall be replaced by Contractor at no cost to Owner.

1.11 PAINTING

- A. Furnished equipment that is pre-painted or pre-finished by manufacturer shall have all nicks, scratches, blemishes, and rust spots cleaned, primed, and refinished prior to final acceptance by Owner.

1.12 COORDINATION DRAWINGS

- A. Refer to section 01 00 00 - General Requirements.
- B. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Products installed in spaces, indicating coordination with general construction, building components, structural elements, architectural features and other building services. Include the following:
 - a. Ductwork.
 - b. Piping greater than 1 inch.
 - c. Electrical conduit greater than 2 inches.
 - d. Structural bracing and supports.
 - e. Equipment.
 - f. Fixtures.
 - 2. Ceiling components.
 - 3. Structural members.
 - a. Foundations.
 - b. Footings.
 - c. Piers.
 - 4. Size and location of access panels.
 - 5. Penetrations of smoke barriers and fire-rated construction.
 - 6. Items penetrating finished ceiling including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.

- d. Grilles, registers and diffusers.
 - e. Access panels.
 - f. Perimeter moldings.
 - g. Fire Sprinklers.
- C. Show clearance for installing, servicing and maintaining equipment.
- D. Prepare drawings specifically for this project; marked up or over-drawn plumbing, electrical, HVAC, or other drawings are not acceptable, except for floor plans.
- E. Use drawing scale of 1/4 inch to 1 foot or larger.
- F. Include a complete equipment list, identifying manufacturer's model numbers and quantities, cross-referenced to product data submittal.
- G. Include wiring diagrams for control panels and all electrical equipment, showing terminations and termination identifications.
- H. Drawings shall be submitted in both PDF format and paper copy on sheet size that matches the construction bid documents. Drawings shall be submitted as both a submittal for the engineer to review and a final copy given to the owner with the PDF files burned onto a CD or hard drive / USB accessible memory stick. Hard drive / USB accessible memory stick and CD provided by Contractor.

1.13 PERMIT AND FEES

- A. Refer to Section 01 00 00 - General Requirements.
- B. Secure all permits and inspections required by applicable authorities and utilities and pay all costs in connection with the Work.
- C. Schedule all inspections required by applicable authorities and utilities. Certificates shall be in triplicate and shall be delivered to Owner.
- D. Piping work, specialties, or equipment shall not be concealed or covered until same have been tested and inspected by municipal inspector(s) and observed by the professional. Municipal inspector(s) record of inspections shall be delivered to Owner. The professional and municipal inspector's witnessing of tests shall not relieve Contractor of his responsibility for concealed piping work and specialties, nor for equipment to perform in accordance with Contract Documents.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Refer to Section 01 00 00 - General Requirements.
- B. All materials and equipment shall be new, without imperfections or blemishes, and shall be protected from the elements prior to installation.
- C. Maintain ambient temperatures and conditions required by manufacturers of products for the installation of materials. Including but limited to the following: Adhesives, mastics, cements, paints and plastics.

2.2 PIPE PORTALS

- A. Construction: 18 gage galvanized steel, unitized construction with integral base plate.
- B. Standard Features:
 - 1. 12" tall above finished roof surface.

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2. Built in raised cant.
3. Wood nailer.
4. 3 lb. density insulation.
5. Acrylic clad ABS plastic cover, fastening screws, graduated step boots with stainless steel clamps.

2.3 VENT FLASHING

- A. Flash vent penetrating roofs with 6 lb. seamless sheet lead of sufficient size to extend a minimum of 10 inches into roofing felts and for membrane roofing systems.

2.4 ANCHORS

- A. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
- B. Washers: ASTM F 844, steel, plain, flat washers.
- C. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.
 1. Stainless-steel studs are available.
 2. Stud: Threaded, zinc-coated carbon steel.
 3. Expansion Plug: Zinc-coated steel.
 4. Washer and Nut: Zinc-coated steel.
- D. Chemical Fasteners: Insert-type-stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.
 1. Bonding Material: ASTM C 881/C 881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
 2. Stainless-steel studs are available.
 3. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud unless otherwise indicated.
 4. Washer and Nut: Zinc-coated steel.

2.5 STEEL

- A. Steel Shapes and Plates: ASTM A 36/A 36M.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install work according to the following:
 1. Federal, State and Local codes.
 2. Manufacturer's recommendations.
- B. Work shall be installed by mechanics skilled in the trade involved.
- C. Inserts:
 1. Provide inserts for placement in concrete formwork.
 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
- D. Coordinated Installation:

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1. All equipment and materials shall be installed to allow access to and to facilitate service, maintenance, repair, replacement, etc., of components to all equipment furnished and installed under this Contract, furnished and installed under all other Divisions of the specifications, and, where applicable, Owner furnished and installed and Owner's existing equipment.
 2. Ductwork, piping, equipment, etc., shall be installed in such a manner as to preserve access to equipment.
 3. Route ductwork and piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
 4. Install ductwork and piping to conserve building space, to not interfere with use of space and other work.
 5. Group ductwork and piping whenever practical at common elevations.
 6. Do not penetrate building structural members unless indicated.
- E. Provide sleeves when penetrating footings, floors, and walls. Seal pipe and sleeve penetrations to achieve fire resistance equivalent to fire separation required.
1. Install per UL listing.
- F. Pipe Portals:
1. Pipe portals provided as Work of this Section shall be coordinated with roof type. Shop drawing submittals for pipe portals, with, or without cants will be considered compatible with existing roof type.
 2. Pipe portals provided as Work of this Section shall be coordinated with requirements of roofing subcontractor. Shop drawing submittals for pipe portals, with or without cants will be considered in compliance with roofer's requirements.
- G. Concrete and Grout:
1. Construct concrete equipment bases of dimensions indicated, but not less than 6 inches larger than supported unit in both directions and minimum of 6 inches in thickness unless otherwise indicated. Follow supported equipment manufacturer's setting templates for anchor bolt and tie locations.
 2. Place grout on concrete bases to provide a smooth bearing surface for equipment.
 3. Place grout around anchors.
 4. Cure placed grout according to manufacturer's printed instructions.
- H. Erection of Metal Supports and Anchorage:
1. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
 2. Field Welding: Comply with AWS D1.1 - Structural Welding Code--Steel.
 3. Comply with the requirements specified in Division 05.

3.2 CLEAN-UP

- A. Upon completion of Work, remove all dirt, foreign materials, markings, stains, fingerprints, etc., from all parts and equipment.
- B. Remove all construction debris and vacuum interior spaces of all compartmental equipment.
- C. Conduct cleaning and disposal operations to comply with codes, ordinances, regulations and anti-pollution laws.

3.3 DUST AND DEBRIS

- A. During construction all openings in piping shall be kept closed except when actual work is being performed on those items. Closures shall be plugs, caps, blind flanges, or other items specifically intended for this purpose. Exercise all necessary care to prevent foreign objects from entering material.
- B. During construction all equipment shall be kept closed except when actual work is being performed on those items. Closures shall be plugs, caps, blind flanges, or other items specifically intended for this purpose. Exercise all necessary care to prevent foreign objects from entering material.
- C. During construction all ducts shall be kept closed except when actual work is being performed on those items. Closures shall be plugs, caps, blind flanges, or other items specifically intended for this purpose. Exercise all necessary care to prevent foreign objects from entering material.
- D. During patching above ceiling, etc., maintain cloths or suitable covers to protect surfaces. Protective measures (drop cloths, protective covers, etc.) shall be placed and sealed over all furniture and equipment to keep items clean and protected against dirt, dust, and debris from entering furniture and equipment that the Owner has not removed.
- E. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

3.4 START-UP

- A. Submit proposed start-up checklist and proposed start-up dates for Owner and Engineer review 14 days prior to start-up.
 - 1. Start-up shall be included for all equipment that is scheduled and has either an electrical connection or fuel connection.
- B. Start-up shall be provided for all equipment and systems.
 - 1. Start-up for equipment shall be performed by:
 - a. Installing Contractor:
 - 1) For equipment with 120 volt and less than 20 amp load electrical connection or less than 100 MBH fuel connection.
 - b. Factory Authorized Personnel:
 - 1) For equipment with 120 volt electrical connections or less than 400 MBH fuel connection.
 - c. Factory Field Personnel:
 - 1) For equipment greater than 120 volt electrical connection or greater than 400 MBH fuel connection.
 - 2. Start-up for systems shall be performed by:
 - a. Installing Contractor:
 - 1) For all systems not listed under 1.b and 1.c above.
 - b. Factory Authorized Personnel:
 - 1) Regulator manufacturer shall start-up all gas systems above 7 psi.
- C. Report:
 - 1. Submit report to Owner within 10 days of completion of start-up.
 - 2. Report shall include:
 - a. Location / System / Equipment Tag.
 - b. Names of Technicians performing Start-up.
 - c. Indicate if Technicians are factory Authorized Personnel or Factory Field Personnel.
 - d. Names of Witnesses.

- e. Start-up Checklist / Information in each start-up section.
- f. List of all set points and initial settings.
- g. Pressure test results.

3.5 TRAINING

- A. Owner-Personnel Training: Owner will designate personnel to be trained in operation and maintenance of the systems.
 - 1. Obtain Owner's approval of training dates.
 - 2. Training sessions will be scheduled by Owner.
 - 3. Submit proposed training agenda for Owner's review and approval at least 30 days prior to start of training.
- B. Training Agenda: Include the following:
 - 1. Overview of system operation.
 - 2. Overview of system equipment and device locations.
 - 3. Manual controls.
 - 4. Manual operation, testing and maintenance of devices.
 - 5. Location of safety devices and resets.
 - 6. User operation of control panel (alarm acknowledgement, alarm silence, reset, alarm resound).
 - 7. Draining and filling procedures for the system.
 - 8. Review of the Operation and Maintenance Manual.
 - 9. Detailed maintenance procedures.
 - 10. Periodic testing procedures.
- C. Training Instructor:
 - 1. The following persons are authorized to provide training:
 - a. Installing Contractor.
 - b. Factory Authorized Technician.
 - c. Factory Start-Up and Training Personnel.

3.6 EXTENDED WARRANTIES

- A. Where extended warranties beyond the normal one year warranty are, as specified herein, to be applied to a particular item of equipment or system, furnish to Owner a description of the warranty along with any required registration and signature of manufacturer's authorized personnel.
- B. Contractor shall be responsible for coordinating with and having the manufacturer administer these warranties for the full extent of time the warranty will be in effect.
- C. Contractor shall be responsible for administering and servicing all extended warranties for the life of each extended warranty at no additional cost to Owner. Owner's responsibility will be for additional costs for parts associated with warranties that are warranted on a pro-rated basis. All labor for administering and servicing the extended warranty, including actual replacement of parts, will be the responsibility of the Contractor for the extended warranty period. All unwarranted shipping and handling costs for parts and equipment will be the responsibility of the Owner.

END OF SECTION 23 05 00

SECTION 23 05 19**METERS AND GAUGES FOR HVAC PIPING****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Pressure gauges and pressure gauge taps.
- B. Thermometers and thermometer wells.

1.2 RELATED REQUIREMENTS

- A. Division 01 - General Requirements
- B. Section 23 09 23 - Direct-Digital Control System for HVAC.
- C. Section 23 21 13 - Hydronic Piping.

1.3 REFERENCE STANDARDS

- A. ASME B40.100 - Pressure Gauges and Gauge Attachments; 2013.
- B. ASTM E1 - Standard Specification for ASTM Liquid-in-Glass Thermometers; 2014.
- C. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers; 2014.

1.4 SUBMITTALS

- A. Product Data: Provide list that indicates use, operating range, total range and location for manufactured components.

PART 2 PRODUCTS**2.1 PRESSURE GAUGES**

- A. Manufacturers:
 - 1. Dwyer Instruments, Inc: www.dwyer-inst.com/#sle.
 - 2. Moeller Instrument Company, Inc: www.moellerinstrument.com/#sle.
 - 3. Omega Engineering, Inc: www.omega.com/#sle.
- B. Pressure Gauges: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.
 - 1. Case: Steel with brass bourdon tube.
 - 2. Size: 4-1/2 inch diameter.
 - 3. Mid-Scale Accuracy: One percent.
 - 4. Scale: Psi and KPa.

2.2 PRESSURE GAUGE TAPPINGS

- A. Gauge Cock: Tee or lever handle, brass for maximum 150 psi.
- B. Needle Valve: Brass, 1/4 inch NPT for minimum 150 psi.
- C. Pulsation Damper: Pressure snubber, brass with 1/4 inch connections.

2.3 STEM TYPE THERMOMETERS

- A. Manufacturers:
 - 1. Dwyer Instruments, Inc: www.dwyer-inst.com/#sle.
 - 2. Omega Engineering, Inc: www.omega.com/#sle.
 - 3. Weksler Glass Thermometer Corp: www.wekslerglass.com/#sle.
- B. Thermometers - Adjustable Angle: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.
 - 1. Size: 9 inch scale.
 - 2. Window: Clear Lexan.
 - 3. Stem: 3/4 inch NPT brass.
 - 4. Accuracy: 2 percent, per ASTM E77.
 - 5. Calibration: Degrees F.

2.4 THERMOMETER SUPPORTS

- A. Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.

2.5 TEST PLUGS

- A. Test Plug: 1/4 inch or 1/2 inch brass fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with neoprene core for temperatures up to 200 degrees F.
- B. Test Kit: Carrying case, internally padded and fitted containing one 2-1/2 inch diameter pressure gauges, one gauge adapters with 1/8 inch probes, two 1 inch dial thermometers.

PART 3 EXECUTION**3.1 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Provide two pressure gages per pump, installing taps before strainers and on suction and discharge of pump. Pipe to gage.
- C. Install pressure gauges with pulsation dampers. Provide gauge cock to isolate each gauge. Provide siphon on gauges in steam systems. Extend nipples and siphons to allow clearance from insulation.
- D. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets. Ensure sockets allow clearance from insulation.
- E. Install thermometers in air duct systems on flanges.
- F. Install thermometer sockets adjacent to controls system thermostat, transmitter, or sensor sockets. Refer to Section 23 09 43. Where thermometers are provided on local panels, duct or pipe mounted thermometers are not required.
- G. Locate duct mounted thermometers minimum 10 feet downstream of mixing dampers, coils, or other devices causing air turbulence.
- H. Coil and conceal excess capillary on remote element instruments.
- I. Provide instruments with scale ranges selected according to service with largest appropriate scale.

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- J. Install gauges and thermometers in locations where they are easily read from normal operating level.
Install vertical to 45 degrees off vertical.
- K. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.
- L. Locate test plugs adjacent thermometers and thermometer sockets.

END OF SECTION 23 05 19

SECTION 23 05 23**GENERAL-DUTY VALVES FOR HVAC PIPING****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Applications.
- B. General requirements.
- C. Globe valves.
- D. Ball valves.
- E. Butterfly valves.
- F. Check valves.
- G. Plug valves.

1.2 RELATED REQUIREMENTS

- A. Division 01 - General Requirements
- B. Section 23 05 53 - Identification for HVAC Piping and Equipment.
- C. Section 23 07 16 - HVAC Equipment Insulation.
- D. Section 23 07 19 - HVAC Piping Insulation.
- E. Section 23 21 13 - Hydronic Piping.

1.3 REFERENCE STANDARDS

- A. API STD 594 - Check Valves: Flanged, Lug Wafer, and Butt-Welding; 2007 (Errata 2010).
- B. ASME B1.20.1 - Pipe Threads, General Purpose (Inch); 2013.
- C. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2010.
- D. ASME B16.5 - Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard; 2013.
- E. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2012.
- F. ASME B16.34 - Valves - Flanged, Threaded and Welding End; 2013.
- G. ASTM A48/A48M - Standard Specification for Gray Iron Castings; 2003 (Reapproved 2012).
- H. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings; 2004 (Reapproved 2014).
- I. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures; 1999 (Reapproved 2014).
- J. ASTM A536 - Standard Specification for Ductile Iron Castings; 1984 (Reapproved 2014).
- K. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings; 2015.

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- L. AWWA C606 - Grooved and Shouldered Joints; 2011.
- M. MSS SP-45 - Bypass and Drain Connections; 2003 (Reaffirmed 2008).
- N. MSS SP-67 - Butterfly Valves; 2011.
- O. MSS SP-72 - Ball Valves with Flanged or Butt-Welding Ends for General Service; 2010.
- P. MSS SP-78 - Cast Iron Plug Valves, Flanged and Threaded Ends; 2011.
- Q. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves; 2013.
- R. MSS SP-85 - Cast Iron Globe & Angle Valves, Flanged and Threaded Ends; 2011.
- S. MSS SP-108 - Resilient-Seated Cast Iron Eccentric Plug Valves; 2012.
- T. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010.
- U. MSS SP-125 - Gray Iron and Ductile Iron In-Line, Spring-Loaded, Center-Guided Check Valves; 2010.

1.4 SUBMITTALS

- A. Product Data: Provide data on valves including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.
- B. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
- C. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listings.
- D. Maintenance Materials: Furnish Owner with one wrench for every five plug valves, in each size of square plug valve head.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.

PART 2 PRODUCTS**2.1 APPLICATIONS**

- A. See drawings for specific valve locations.
- B. Provide the following valves for the applications if not indicated on drawings:
 - 1. Throttling (Hydronic): Ball.
 - 2. Isolation (Shutoff): Butterfly and Ball.
 - 3. Swing Check (Pump Outlet):
 - a. 2 NPS and Smaller: Bronze with bronze disc.
 - b. 2-1/2 NPS and Larger: Iron with center-guided with resilient seat.
- C. Required Valve End Connections for Non-Wafer Types:
 - 1. Steel Pipe:
 - a. 2 NPS and Smaller: Threaded ends.
 - b. 2-1/2 NPS and Larger: Grooved ends.
 - 2. Copper Tube:
 - a. 2 NPS and Smaller: Threaded ends (Exception: Solder-joint valve-ends).
 - b. 2-1/2 NPS and Larger: Grooved ends.
- D. Heating Hot and Chilled Water Valves:

1. 2 NPS and Smaller, Brass and Bronze Valves:
 - a. Threaded ends.
 - b. Ball: Full port, one piece, brass trim.
2. 2-1/2 NPS and Larger, Iron Valves:
 - a. 2-1/2 NPS to 4 NPS: Threaded ends.
 - b. Ball: 2-1/2 NPS to 10 NPS, Class 150.
 - c. Single-Flange Butterfly: 2-1/2 NPS to 12 NPS, aluminum-bronze disc, EPDM seat, 200 CWP.
 - d. Center-Guided Check: Compact-wafer, metal seat, Class 125.
 - e. Globe: 2-1/2 NPS to 12 NPS, Class 125.

2.2 GENERAL REQUIREMENTS

- A. Valve Pressure and Temperature Ratings: No less than rating indicated; as required for system pressures and temperatures.
- B. Valve Sizes: Match upstream piping unless otherwise indicated.
- C. Valve Actuator Types:
 1. Hand Lever: Quarter-turn valves 6 NPS and smaller except plug valves.
 2. Wrench: Plug valves with square heads.
- D. Valves in Insulated Piping: Provide 2 NPS stem extensions and the following features:
 1. Ball Valves: Extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
 2. Butterfly Valves: Extended neck.
 3. Memory Stops: Fully adjustable after insulation is installed.
- E. Valve-End Connections:
 1. Threaded End Valves: ASME B1.20.1.
 2. Flanges on Iron Valves: ASME B16.1 for flanges on iron valves.
 3. Pipe Flanges and Flanged Fittings 1/2 NPS through 24 NPS: ASME B16.5.
 4. Solder Joint Connections: ASME B16.18.
 5. Grooved End Connections: AWWA C606.
- F. General ASME Compliance:
 1. Building Services Piping Valves: ASME B31.9.
- G. Bronze Valves:
 1. Fabricate from dezincification resistant material.
 2. Copper alloys containing more than 15 percent zinc are not permitted.
- H. Valve Bypass and Drain Connections: MSS SP-45.
- I. Source Limitations: Obtain each valve type from a single manufacturer.

2.3 IRON, GLOBE VALVES

- A. Class 125: CWP Rating: 200 psig.; and Class 250: CWP Rating: 500 psig.:
 1. Comply with MSS SP-85, Type I.
 2. Body: Gray iron; ASTM A126, with bolted bonnet.
 3. Ends: Flanged.
 4. Trim: Bronze.
 5. Packing and Gasket: Asbestos free.
 6. Operator: Handwheel or chainwheel.

7. Manufacturers:
 - a. Apollo Valves: www.apollovalves.com/#sle.
 - b. Ferguson Enterprises Inc: www.fnw.com/#sle.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.

2.4 BRASS, BALL VALVES

- A. Two Piece, Regular Port with Stainless Steel Trim:
 1. Comply with MSS SP-110.
 2. SWP Rating: 150 psig.
 3. CWP Rating: 600 psig, WOG.
 4. Body: Forged brass.
 5. Ends: Threaded.
 6. Seats: PTFE, TFE, or PTFE or TFE.
 7. Stem: Stainless Steel.
 8. Ball: Chrome-plated brass.
 9. Manufacturers:
 - a. Apollo Valves: www.apollovalves.com/#sle.
 - b. Ferguson Enterprises Inc: www.fnw.com/#sle.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.

2.5 BRONZE, BALL VALVES

- A. General:
 1. Fabricate from dezincification resistant material.
 2. Copper alloys containing more than 15 percent zinc are not permitted.
- B. Two Piece, Regular Port with Bronze or Brass Trim:
 1. Comply with MSS SP-110.
 2. SWP Rating: 150 psig.
 3. CWP Rating: 600 psig.
 4. Body: Forged bronze or dezincified-brass alloy.
 5. Ends: Threaded.
 6. Seats: PTFE.
 7. Stem: Bronze or brass.
 8. Ball: Chrome plated brass.
 9. Manufacturers:
 - a. Apollo Valves: www.apollovalves.com/#sle.
 - b. Viega LLC: www.viega.com/#sle.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.

2.6 IRON, BALL VALVES

- A. Split Body, Full Port:
 1. Comply with MSS SP-72.
 2. CWP Rating: 200 psig.
 3. Body: ASTM A126, gray iron.
 4. Ends: Flanged.
 5. Seats: PTFE.
 6. Stem: Stainless steel.
 7. Ball: Stainless steel.

2.7 IRON, SINGLE FLANGE BUTTERFLY VALVES

- A. Lug Style: Bi-directional dead-end service without use of downstream flange.
 - 1. Comply with MSS SP-67, Type I.
 - 2. CWP Rating: 150 psig, and 200 psig.
 - 3. Body Material: ASTM A126 cast iron or ASTM A536 ductile iron.
 - 4. Stem: One or two-piece stainless steel.
 - 5. Seat: NBR.
 - 6. Disc: Coated ductile iron.
 - 7. Manufacturers:
 - a. Apollo Valves: www.apollovalves.com/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.

2.8 IRON, GROOVED-END BUTTERFLY VALVES

- A. CWP Rating: 175 psig (1200 kPa) and 200 psig (1389 kPa): 10 NPS (250 DN) or larger.
 - 1. Comply with MSS SP-67, Type I.
 - 2. Body: Coated ductile iron.
 - 3. Stem: Stainless steel.
 - 4. Disc: Coated ductile iron.
 - 5. Disc Seal: EPDM.
 - 6. Manufacturers:
 - a. Victaulic _____
 - b. Substitutions: See Section 01 60 00 - Product Requirements.

2.9 BRONZE, LIFT CHECK VALVES

- A. Class 125:
 - 1. Comply with MSS SP-80, Type 1, Metal Disc to Metal Seat and Type 2, Nonmetallic Disc to Metal Seat.
 - 2. CWP Rating: 200 psig.
 - 3. Design: Vertical flow.
 - 4. Body: Bronze.
 - 5. Ends: Threaded.
 - 6. Disc (Type 1): Bronze.
 - 7. Disc (Type 2): NBR or PTFE.
 - 8. Manufacturers:
 - a. Metraflex.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.

2.10 BRONZE, SWING CHECK VALVES

- A. Class 125: CWP Rating: 200 psig (1380 kPa) and Class 150: CWP Rating: 300 psig (2070 kPa).
 - 1. Comply with MSS SP-80, Type 3.
 - 2. Body Design: Horizontal flow.
 - 3. Body Material: Bronze, ASTM B62.
 - 4. Ends: Threaded.
 - 5. Disc: Bronze.

2.11 IRON, CENTER-GUIDED CHECK VALVES

- A. Class 125, Compact-Wafer:

1. Comply with MSS SP-125.
 2. 2-1/2 NPS to 12 NPS, CWP Rating: 200 psig.
 3. Body Material: ASTM A126, gray iron.
 4. Metal Seat: Bronze.
 5. Resilient Seat: EPDM or NBR.
 6. Manufacturers:
 - a. Apollo Valves: www.apollovalves.com/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Class 150, Compact-Wafer:
1. Comply with MSS SP-125.
 2. 2-1/2 NPS to 12 NPS, CWP Rating: 300 psig.
 3. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
 4. Metal Seat: Bronze.
 5. Resilient Seat: EPDM or NBR.
 6. Manufacturers:
 - a. Metraflex.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.

2.12 LUBRICATED PLUG VALVES

- A. Regular Gland and Cylindrical with Threaded Ends:
1. Comply with MSS SP-78, Type II.
 2. Class 125: 2-1/2 NPS to 12 NPS, CWP Rating: 200 psig.
 3. Body Material: Cast iron with lubrication sealing system.
 4. Pattern: Regular or short.
 5. Plug: Cast iron or bronze with sealant groove.

2.13 ECCENTRIC PLUG VALVES

- A. Resilient Seating with Flanged Ends.
1. Comply with MSS SP-108.
 2. CWP Rating: 175 psig minimum.
 3. Body and Plug: Gray or ductile iron.
 4. Bearings: Oil-impregnated bronze or Stainless Steel.
 5. Stem-Seal Packing: Asbestos free.
 6. Plug, Resilient-Seating Material: Approved for potable water service.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Discard all packing materials and verify that valve interior, including threads and flanges, are completely clean without signs of damage or degradation that could result in leakage.
- B. Verify valve parts to be fully operational in all positions from closed to fully open.
- C. Confirm gasket material to be suitable for the service, to be of correct size, and without defects that could compromise effectiveness.
- D. Should valve is determined to be defective, replace with new valve.

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3.2 INSTALLATION

- A. Provide unions or flanges with valves to facilitate equipment removal and maintenance while maintaining system operation and full accessibility for servicing.
- B. Provide separate valve support as required and locate valve with stem at or above center of piping, maintaining unimpeded stem movement.
- C. Where valve support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc-rich primer to welds.
- D. Install check valves where necessary to maintain direction of flow as follows:
 - 1. Lift Check: Install with stem plumb and vertical.

END OF SECTION 23 05 23

SECTION 23 05 29**HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Support and attachment components for equipment, piping, and other HVAC/hydronic work.

1.2 RELATED REQUIREMENTS

- A. Division 01 - General Requirements

1.3 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2015.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2009.
- C. ASTM A181/A181M - Standard Specification for Carbon Steel Forgings, for General - Purpose Piping; 2013.
- D. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2014.
- E. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings; 1999 (Reapproved 2014).
- F. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2013.
- G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.
- H. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2014.
- I. MFMA-4 - Metal Framing Standards Publication; 2004.
- J. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2009.
- K. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
 - 2. Coordinate the work with other trades to provide additional framing and materials required for installation.
 - 3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
 - 4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
 - 5. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel (strut) framing systems, nonpenetrating rooftop supports, post-installed concrete and masonry anchors, and thermal insulated pipe supports.
- B. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.
 - 1. Application of protective inserts, saddles, and shields at pipe hangers for each type of insulation and hanger.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.6 QUALITY ASSURANCE

- A. Comply with applicable building code.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Installer Qualifications for Powder-Actuated Fasteners (when specified): Certified by fastener system manufacturer with current operator's license.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS**2.1 SUPPORT AND ATTACHMENT COMPONENTS**

- A. General Requirements:
 - 1. Comply with MSS SP-58.
 - 2. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of plumbing work.
 - 3. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
 - 4. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported 1.7. Include consideration for vibration, equipment operation, and shock loads where applicable.
 - 5. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
 - a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
 - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.
 - c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
 - 1. Manufacturers:

- a. Unistrut, a brand of Atkore International Inc: www.unistrut.com/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
 2. Comply with MFMA-4.
 3. Channel Material:
 - a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.
 - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
 4. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch.
 5. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height.
- C. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
 1. Minimum Size, Unless Otherwise Indicated or Required:
 - a. Equipment Supports: 1/2 inch diameter.
 - b. Piping up to 1 inch (27 mm) nominal: 1/4 inch diameter.
 - c. Piping larger than 1 inch (27 mm) nominal: 3/8 inch diameter.
 - d. Trapeze Support for Multiple Pipes: 3/8 inch diameter.
- D. Thermal Insulated Pipe Supports:
 1. General Construction and Requirements:
 - a. Insulated pipe supports to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.
 - b. Surface Burning Characteristics: Flame spread index/smoke developed index of 5/30, maximum, when tested in accordance with ASTM E84 or UL 723.
 - c. Pipe supports to be provided for nominally sized, 1/2 inch to 30 inch iron pipes.
 - d. Insulation inserts to consist of rigid polyisocyanurate (urethane) insulation surrounded by a 360 degree, PVC jacketing.
 2. PVC Jacket:
 - a. Pipe insulation protection shields to be provided with a ball bearing hinge and locking seam.
 - b. Moisture Vapor Transmission: 0.0071 perm inch, when tested in accordance with ASTM E96/E96M.
 - c. Thickness: 60 mil.
 3. Pipe insulation protection shields to be provided at the hanger points and guide locations on pipes requiring insulation as indicated on drawings.
- E. Pipe Supports:
 1. Liquid Temperatures Up To 122 degrees F:
 - a. Overhead Support: MSS SP-58 Types 1, 3 through 12.
 - b. Support From Below: MSS SP-58 Types 35 through 38.
 2. Operating Temperatures from 122 to 446 degrees F:
 - a. Overhead Support: MSS SP-58 Type 1 or 3 through 12, with appropriate saddle of MSS SP-58 Type 40 for insulated pipe.
 - b. Roller Support: MSS SP-58 Types 41 or 43 through 46, with appropriate saddle of MSS SP-58 Type 39 for insulated pipe.
 - c. Sliding Support: MSS SP-58 Types 35 through 38.
- F. Beam Clamps: MSS SP-58 Types 19 through 23, 25 or 27 through 30 based on required load.
 1. Material: ASTM A36/A36M carbon steel or ASTM A181/A181M forged steel.
 2. Provide clamps with hardened steel cup-point set screws and lock-nuts for anchoring in place.
- G. Riser Clamps:
 1. Provide copper plated clamps for copper tubing support.
 2. For insulated pipe runs, provide two bolt-type clamps designed for installation under insulation.

- H. Strut Clamps: Two-piece pipe clamp.
- I. Pipe Hangers: For a given pipe run, use hangers of the same type and material.
 - 1. Manufacturers:
 - a. Ferguson Enterprises Inc: www.fnw.com/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
 - c. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.
 - 2. Material: Malleable iron, ASTM A47/A47M; or carbon steel, ASTM A36/A36M.
 - 3. Provide coated or plated hangers to isolate steel hangers from dissimilar metal tube or pipe.
- J. Dielectric Barriers: Provide between metallic supports and metallic piping and associated items of dissimilar type; acceptable dielectric barriers include rubber or plastic sheets or coatings attached securely to pipe or item.
- K. Anchors and Fasteners:
 - 1. Manufacturers - Mechanical Anchors:
 - a. Hilti, Inc: www.us.hilti.com/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
 - 2. Manufacturers - Powder-Actuated Fastening Systems:
 - a. Hilti, Inc: www.us.hilti.com/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
 - 3. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
 - 4. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
 - 5. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
 - 6. Hollow Masonry: Use toggle bolts.
 - 7. Hollow Stud Walls: Use toggle bolts.
 - 8. Steel: Use beam clamps, machine bolts, or welded threaded studs.
 - 9. Sheet Metal: Use sheet metal screws.
 - 10. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
 - a. Comply with MFMA-4.
 - b. Channel Material: Use galvanized steel.
 - c. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch minimum base metal thickness.
 - d. Manufacturer: Same as manufacturer of metal channel (strut) framing system.
- L. Pipe Installation Accessories:
 - 1. Copper Pipe Supports:
 - a. Manufacturers:
 - 1) HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com/#sle.
 - 2) Substitutions: See Section 01 60 00 - Product Requirements.
 - 3) Source Limitations: Furnish supports, associated fittings, accessories, and hardware produced by a single manufacturer.
 - 2. Inserts and Clamps:
 - a. Manufacturers:
 - 1) HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com/#sle.
 - 2) Substitutions: See Section 01 60 00 - Product Requirements.
 - 3) Source Limitations: Furnish supports, associated fittings, accessories, and hardware produced by a single manufacturer.

2.2 RETROFIT PIPING COVER SYSTEM

- A. Manufacturers:
 - 1. DecoShield Systems, Inc: www.decoshield.com/#sle.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.
- B. General Requirements:
 - 1. Surface Burning Characteristics: Flame spread index/smoke developed index of 20/250, maximum, when tested in accordance with ASTM E84 or UL 723.

PART 3 EXECUTION**3.1 EXAMINATION**

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive support and attachment components.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.
- C. Unless specifically indicated or approved by Engineer, do not provide support from suspended ceiling support system or ceiling grid.
- D. Unless specifically indicated or approved by Engineer, do not provide support from roof deck.
- E. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- F. Provide thermal insulated pipe supports complete with hangers and accessories. Install thermal insulated pipe supports during the installation of the piping system.
- G. Equipment Support and Attachment:
 - 1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
 - 2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
 - 3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
 - 4. Unless otherwise indicated, mount floor-mounted equipment on properly sized 3 inch high concrete pad constructed in accordance with Section 03 30 00.
 - 5. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- H. Preset Concrete Inserts: Use manufacturer-provided closure strips to inhibit concrete seepage during concrete pour.
- I. Secure fasteners according to manufacturer's recommended torque settings.

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J. Remove temporary supports.

END OF SECTION 23 05 29

SECTION 23 05 53**IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Nameplates.
- B. Tags.
- C. Adhesive-backed duct markers.
- D. Stencils.
- E. Pipe markers.
- F. Ceiling tacks.

1.2 RELATED REQUIREMENTS

- A. Division 01 - General Requirements

1.3 REFERENCE STANDARDS

- A. ASME A13.1 - Scheme for the Identification of Piping Systems; 2007.
- B. ASTM D709 - Standard Specification for Laminated Thermosetting Materials; 2013.

1.4 SUBMITTALS

- A. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.
- B. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- C. Product Data: Provide manufacturers catalog literature for each product required.
- D. Manufacturer's Installation Instructions: Indicate special procedures, and installation.
- E. Project Record Documents: Record actual locations of tagged valves.

PART 2 PRODUCTS**2.1 IDENTIFICATION APPLICATIONS**

- A. Air Handling Units: Nameplates.
- B. Air Terminal Units: Tags.
- C. Automatic Controls: Tags. Key to control schematic.
- D. Control Panels: Nameplates.
- E. Dampers: Ceiling tacks, where located above lay-in ceiling.
- F. Ductwork: Nameplates.
- G. Heat Transfer Equipment: Nameplates.

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- H. Instrumentation: Tags.
- I. Major Control Components: Nameplates.
- J. Piping: Tags.
- K. Pumps: Nameplates.
- L. Relays: Tags.
- M. Small-sized Equipment: Tags.
- N. Tanks: Nameplates.
- O. Valves: Tags and ceiling tacks where located above lay-in ceiling.

2.2 NAMEPLATES

- A. Manufacturers:
 - 1. Advanced Graphic Engraving, LLC: www.advancedgraphicengraving.com/#sle.
 - 2. Brimar Industries, Inc: www.pipemarker.com/#sle.
 - 3. Craftmark Pipe Markers: www.craftmarkid.com/#sle.
 - 4. Seton Identification Products, a Tricor Direct Company: www.seton.com/#sle.
 - 5. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Letter Color: White.
- C. Letter Height: 1/4 inch.
- D. Background Color: Black.
- E. Plastic: Comply with ASTM D709.

2.3 TAGS

- A. Manufacturers:
 - 1. Advanced Graphic Engraving: www.advancedgraphicengraving.com/#sle.
 - 2. Brimar Industries, Inc: www.pipemarker.com/#sle.
 - 3. Craftmark Pipe Markers: www.craftmarkid.com/#sle.
 - 4. Seton Identification Products, a Tricor Company: www.seton.com/#sle.
 - 5. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter.
- C. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.
- D. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.

2.4 ADHESIVE-BACKED DUCT MARKERS

- A. Manufacturers:
 - 1. Brimar Industries, Inc: www.pipemarker.com/#sle.
 - 2. Craftmark Pipe Markers: www.craftmarkid.com/#sle.
 - 3. Substitutions: See Section 01 60 00 - Product Requirements.

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- B. Material: High gloss acrylic adhesive-backed vinyl film 0.0032 inch; printed with UV and chemical resistant inks.
- C. Style: Individual Label.
- D. Color: Yellow/Black.

2.5 STENCILS

- A. Manufacturers:
 - 1. Brady Corporation: www.bradycorp.com/#sle.
 - 2. Craftmark Pipe Markers: www.craftmarkid.com/#sle.
 - 3. Seton Identification Products, a Tricor Company: www.seton.com/#sle.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Stencils: With clean cut symbols and letters of following size:
 - 1. 3/4 to 1-1/4 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 1/2 inch high letters.
 - 2. 1-1/2 to 2 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 3/4 inch high letters.
 - 3. 2-1/2 to 6 inch Outside Diameter of Insulation or Pipe: 12 inch long color field, 1-1/4 inch high letters.
 - 4. Ductwork and Equipment: 2-1/2 inch high letters.
- C. Stencil Paint: As specified in Section 09 91 23, semi-gloss enamel, colors complying with ASME A13.1.

2.6 PIPE MARKERS

- A. Manufacturers:
 - 1. Brady Corporation: www.bradycorp.com/#sle.
 - 2. Craftmark Pipe Markers: www.craftmarkid.com/#sle.
 - 3. Seton Identification Products, a Tricor Company: www.seton.com/#sle.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Color: Comply with ASME A13.1.
- C. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
- D. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.
- E. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.
- F. Color code as follows:
 - 1. Heating, Cooling, and Boiler Feedwater: Green with white letters.

2.7 CEILING TACKS

- A. Manufacturers:
 - 1. Craftmark Pipe Markers: www.craftmarkid.com/#sle.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.

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- B. Description: Steel with 3/4 inch diameter color coded head.

PART 3 EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.
- B. Prepare surfaces in accordance with Section 09 91 23 for stencil painting.

3.2 INSTALLATION

- A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Install tags with corrosion resistant chain.
- C. Apply stencil painting in accordance with Section 09 91 23.
- D. Install plastic pipe markers in accordance with manufacturer's instructions.
- E. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
- F. Use tags on piping 3/4 inch diameter and smaller.
1. Identify service, flow direction, and pressure.
 2. Install in clear view and align with axis of piping.
 3. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.
- G. Install ductwork with plastic nameplates. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.
- H. Locate ceiling tacks to locate valves or dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION 23 05 53

SECTION 23 05 94**TESTING, ADJUSTING, AND BALANCING FOR HVAC****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Testing, adjustment, and balancing of air systems.
- B. Testing, adjustment, and balancing of hydronic systems.
- C. Measurement of final operating condition of HVAC systems.

1.2 RELATED REQUIREMENTS

- A. Division 01 - General Requirements

1.3 REFERENCE STANDARDS

- A. AABC (NSTSB) - AABC National Standards for Total System Balance, 7th Edition; 2016.
- B. ASHRAE Std 111 - Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems; 2008.
- C. NEBB (TAB) - Procedural Standards for Testing Adjusting Balancing of Environmental Systems; 2005, Seventh Edition.
- D. SMACNA (TAB) - HVAC Systems Testing, Adjusting and Balancing; 2002.

1.4 SUBMITTALS

- A. Submittals:
 - 1. Installer 23 05 93 - 001 - A
 - 2. Tab Plan 23 05 93 - 002 - A
 - 3. Control System Coordination 23 05 93 - 003 - A
 - 4. Preliminary tab report of existing system 23 05 93 - 004 - A
 - 5. Final Tab 23 05 93 - 005 - A
- B. Installer Qualifications: Submit name of adjusting and balancing agency and TAB supervisor for approval within 30 days after award of Contract.
- C. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
 - 1. Submit to Engineer.
 - 2. Submit six weeks prior to starting the testing, adjusting, and balancing work.
 - 3. Include certification that the plan developer has reviewed the contract documents, the equipment and systems, and the control system with the Engineer and other installers to sufficiently understand the design intent for each system.
 - 4. Include at least the following in the plan:
 - a. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
 - b. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
 - c. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
 - d. Final test report forms to be used.

- e. Detailed step-by-step procedures for TAB work for each system and issue, including:
 - 1) Terminal flow calibration (for each terminal type).
 - 2) Diffuser proportioning.
 - 3) Branch/submain proportioning.
 - 4) Total flow calculations.
 - 5) Rechecking.
 - 6) Diversity issues.
 - f. Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and methods to verify this.
 - g. Confirmation of understanding of the outside air ventilation criteria under all conditions.
 - h. Method of verifying and setting minimum outside air flow rate will be verified and set and for what level (total building, zone, etc.).
 - i. Time schedule for TAB work to be done in phases (by floor, etc.).
 - j. Description of TAB work for areas to be built out later, if any.
 - k. Time schedule for deferred or seasonal TAB work, if specified.
 - l. Procedures for formal deficiency reports, including scope, frequency and distribution.
- D. Control System Coordination Reports: Communicate in writing to the controls installer all setpoint and parameter changes made or problems and discrepancies identified during TAB that affect, or could affect, the control system setup and operation.
- E. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
1. Submit under provisions of Section 01 40 00.
 2. Revise TAB plan to reflect actual procedures and submit as part of final report.
 3. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Engineer and for inclusion in operating and maintenance manuals.
 4. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
 5. Form of Test Reports: Where the TAB standard being followed recommends a report format, use that; otherwise, follow ASHRAE Std 111.
 6. Units of Measure: Report data in both I-P (inch-pound) and SI (metric) units.
 7. Include the following on the title page of each report:
 - a. Name of Testing, Adjusting, and Balancing Agency.
 - b. Address of Testing, Adjusting, and Balancing Agency.
 - c. Telephone number of Testing, Adjusting, and Balancing Agency.
 - d. Project name.
 - e. Project location.
 - f. Project Engineer.
 - g. Project Contractor.
 - h. Report date.
- F. Project Record Documents: Record actual locations of flow measuring stations and balancing valves and rough setting.

PART 2 PRODUCTS - NOT USED**PART 3 EXECUTION****3.1 GENERAL REQUIREMENTS**

- A. Perform total system balance in accordance with one of the following:
1. AABC (NSTSB), AABC National Standards for Total System Balance.

2. ASHRAE Std 111, Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.
 3. NEBB Procedural Standards for Testing Adjusting Balancing of Environmental Systems.
 4. SMACNA (TAB).
- B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.
- C. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.
- D. TAB Agency Qualifications:
1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
 2. Certified by one of the following:
 - a. AABC, Associated Air Balance Council; upon completion submit AABC National Performance Guaranty.
 - b. NEBB, National Environmental Balancing Bureau.
 - c. TABB, The Testing, Adjusting, and Balancing Bureau of National Energy Management Institute.
- E. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.

3.2 EXAMINATION

- A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
1. Systems are started and operating in a safe and normal condition.
 2. Temperature control systems are installed complete and operable.
 3. Proper thermal overload protection is in place for electrical equipment.
 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 5. Duct systems are clean of debris.
 6. Fans are rotating correctly.
 7. Fire and volume dampers are in place and open.
 8. Air coil fins are cleaned and combed.
 9. Access doors are closed and duct end caps are in place.
 10. Air outlets are installed and connected.
 11. Duct system leakage is minimized.
 12. Hydronic systems are flushed, filled, and vented.
 13. Pumps are rotating correctly.
 14. Proper strainer baskets are clean and in place.
 15. Service and balance valves are open.
- B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.
- C. Beginning of work means acceptance of existing conditions.

3.3 ADJUSTMENT TOLERANCES

- A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 5 percent of design for return and exhaust systems.
- B. Air Outlets and Inlets: Adjust total to within plus 5 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 5 percent of design.

- C. Hydronic Systems: Adjust to within plus or minus 5 percent of design.

3.4 RECORDING AND ADJUSTING

- A. Ensure recorded data represents actual measured or observed conditions.
- B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- C. Mark on the drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.
- D. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- E. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

3.5 EXISTING SYSTEM

- A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.
1. Measure and record the operating speed, airflow, and static pressure of each fan.
 2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
 3. Check the refrigerant charge.
 4. Check the condition of filters.
 5. Check the condition of coils.
 6. Check the operation of the drain pan and condensate-drain trap.
 7. Check bearings and other lubricated parts for proper lubrication.
 8. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.
- B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:
1. New filters are installed.
 2. Coils are clean and fins combed.
 3. Drain pans are clean.
 4. Fans are clean.
 5. Bearings and other parts are properly lubricated.
 6. Deficiencies noted in the preconstruction report are corrected.
- C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.
1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
 2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
 3. If calculations increase or decrease the air flow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.
 4. Balance each air outlet.

3.6 AIR SYSTEM PROCEDURE

- A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.
- B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
- C. Measure air quantities at air inlets and outlets.
- D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
- E. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.
- F. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.
- G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.
- I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
- K. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.
- L. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches positive static pressure near the building entries.
- M. For variable air volume system powered units set volume controller to air flow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable air volume temperature control.

3.7 WATER SYSTEM PROCEDURE

- A. Adjust water systems to provide required or design quantities.
- B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gages to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.
- C. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- D. Effect system balance with automatic control valves fully open to heat transfer elements.
- E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.

- F. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

3.8 SCOPE

- A. Test, adjust, and balance the following:
1. HVAC Pumps.
 2. Packaged Steel Water Tube Boilers.
 3. Packaged Terminal Air Conditioning Units.
 4. Unit Air Conditioners.
 5. Air Coils.
 6. Terminal Heat Transfer Units.
 7. Air Handling Units.
 8. Fans.
 9. Air Filters.
 10. Air Terminal Units.
 11. Air Inlets and Outlets.

3.9 MINIMUM DATA TO BE REPORTED

- A. Electric Motors:
1. Manufacturer.
 2. Model/Frame.
 3. HP/BHP.
 4. Phase, voltage, amperage; nameplate, actual, no load.
 5. RPM.
 6. Service factor.
 7. Starter size, rating, heater elements.
 8. Sheave Make/Size/Bore.
- B. V-Belt Drives:
1. Identification/location.
 2. Required driven RPM.
 3. Driven sheave, diameter and RPM.
 4. Belt, size and quantity.
 5. Motor sheave diameter and RPM.
 6. Center to center distance, maximum, minimum, and actual.
- C. Pumps:
1. Identification/number.
 2. Manufacturer.
 3. Size/model.
 4. Impeller.
 5. Service.
 6. Design flow rate, pressure drop, BHP.
 7. Actual flow rate, pressure drop, BHP.
 8. Discharge pressure.
 9. Suction pressure.
 10. Total operating head pressure.
 11. Shut off, discharge and suction pressures.
 12. Shut off, total head pressure.

D. Combustion Equipment:

1. Boiler manufacturer.
2. Model number.
3. Serial number.
4. Firing rate.
5. Overfire draft.
6. Gas meter timing dial size.
7. Gas meter time per revolution.
8. Gas pressure at meter outlet.
9. Gas flow rate.
10. Heat input.
11. Burner manifold gas pressure.
12. Percent carbon monoxide (CO).
13. Percent carbon dioxide (CO₂).
14. Percent oxygen (O₂).
15. Percent excess air.
16. Flue gas temperature at outlet.
17. Ambient temperature.
18. Net stack temperature.
19. Percent stack loss.
20. Percent combustion efficiency.
21. Heat output.

E. Air Cooled Condensers:

1. Identification/number.
2. Location.
3. Manufacturer.
4. Model number.
5. Serial number.
6. Entering DB air temperature, design and actual.
7. Leaving DB air temperature, design and actual.
8. Number of compressors.

F. Cooling Coils:

1. Identification/number.
2. Location.
3. Service.
4. Manufacturer.
5. Air flow, design and actual.
6. Entering air DB temperature, design and actual.
7. Entering air WB temperature, design and actual.
8. Leaving air DB temperature, design and actual.
9. Leaving air WB temperature, design and actual.
10. Water flow, design and actual.
11. Water pressure drop, design and actual.
12. Entering water temperature, design and actual.
13. Leaving water temperature, design and actual.
14. Saturated suction temperature, design and actual.
15. Air pressure drop, design and actual.

G. Heating Coils:

1. Identification/number.
2. Location.
3. Service.
4. Manufacturer.
5. Air flow, design and actual.
6. Water flow, design and actual.
7. Water pressure drop, design and actual.
8. Entering water temperature, design and actual.
9. Leaving water temperature, design and actual.
10. Entering air temperature, design and actual.
11. Leaving air temperature, design and actual.
12. Air pressure drop, design and actual.

H. Air Moving Equipment:

1. Location.
2. Manufacturer.
3. Model number.
4. Serial number.
5. Arrangement/Class/Discharge.
6. Air flow, specified and actual.
7. Return air flow, specified and actual.
8. Outside air flow, specified and actual.
9. Total static pressure (total external), specified and actual.
10. Inlet pressure.
11. Discharge pressure.
12. Sheave Make/Size/Bore.
13. Number of Belts/Make/Size.
14. Fan RPM.

I. Return Air/Outside Air:

1. Identification/location.
2. Design air flow.
3. Actual air flow.
4. Design return air flow.
5. Actual return air flow.
6. Design outside air flow.
7. Actual outside air flow.
8. Return air temperature.
9. Outside air temperature.
10. Required mixed air temperature.
11. Actual mixed air temperature.
12. Design outside/return air ratio.
13. Actual outside/return air ratio.

J. Fans:

1. Location.
2. Manufacturer.
3. Model number.
4. Serial number.

5. Air flow, specified and actual.
 6. Total static pressure (total external), specified and actual.
 7. Inlet pressure.
 8. Discharge pressure.
 9. Sheave Make/Size/Bore.
 10. Number of Belts/Make/Size.
 11. Fan RPM.
- K. Duct Traverses:
1. System zone/branch.
 2. Duct size.
 3. Area.
 4. Design velocity.
 5. Design air flow.
 6. Test velocity.
 7. Test air flow.
 8. Duct static pressure.
 9. Air temperature.
 10. Air correction factor.
- L. Duct Leak Tests:
1. Description of ductwork under test.
 2. Duct design operating pressure.
 3. Duct design test static pressure.
 4. Duct capacity, air flow.
 5. Maximum allowable leakage duct capacity times leak factor.
 6. Test apparatus:
 - a. Blower.
 - b. Orifice, tube size.
 - c. Orifice size.
 - d. Calibrated.
 7. Test static pressure.
 8. Test orifice differential pressure.
 9. Leakage.
- M. Terminal Unit Data:
1. Manufacturer.
 2. Type, constant, variable, single, dual duct.
 3. Identification/number.
 4. Location.
 5. Model number.
 6. Size.
 7. Minimum static pressure.
 8. Minimum design air flow.
 9. Maximum design air flow.
 10. Maximum actual air flow.
 11. Inlet static pressure.
- N. Air Distribution Tests:
1. Air terminal number.
 2. Room number/location.

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3. Terminal type.
4. Terminal size.
5. Area factor.
6. Design velocity.
7. Design air flow.
8. Test (final) velocity.
9. Test (final) air flow.
10. Percent of design air flow.

END OF SECTION 23 05 94

SECTION 23 07 13**DUCT INSULATION****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Duct insulation.
- B. Insulation jackets.

1.2 RELATED REQUIREMENTS

- A. Division 01 - General Requirements
- B. Section 23 05 53 - Identification for HVAC Piping and Equipment.
- C. Section 23 31 00 - HVAC Ducts and Casings: Glass fiber ducts.

1.3 REFERENCE STANDARDS

- A. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2010.
- B. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2014.
- C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.
- D. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2014.
- E. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

PART 2 PRODUCTS**2.1 REGULATORY REQUIREMENTS**

- A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.2 FIBERGLASS DUCT WRAP INSULATION DI-2

- A. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket.
- B. Comply with ASTM E84, NFPA 90A, or NFPA 90B.
- C. Maximum Thermal Conductivity: 0.29 Btu x in./h x sq. ft. x deg F mean temperature.
- D. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
- E. 2" wide tape for sealing joints.
- F. For outdoor installations, insulation jacket shall be 20 mill PVC or 0.016 inch aluminum.

2.3 GLASS FIBER, RIGID DI-4

- A. Manufacturer:
 - 1. CertainTeed Corporation: www.certainteed.com/#sle.

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2. Johns Manville: www.jm.com/#sle.
 3. Knauf Insulation: www.knaufinsulation.com/#sle.
 4. Owens Corning Corporation; 700 Series FIBERGLAS Insulation: www.ocbuildingspec.com/#sle.
 5. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Insulation: ASTM C612; rigid, noncombustible blanket.
1. K Value: 0.24 at 75 degrees F, when tested in accordance with ASTM C518.
 2. Maximum Service Temperature: 450 degrees F.
 3. Maximum Water Vapor Absorption: 5.0 percent.
 4. Maximum Density: 8.0 lb/cu ft.
- C. Vapor Barrier Jacket:
1. Kraft paper with glass fiber yarn and bonded to aluminized film.
 2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 3. Secure with pressure sensitive tape.
- D. Outdoor installation shall have white EPDM covering.

PART 3 EXECUTION**3.1 EXAMINATION**

- A. Test ductwork for design pressure prior to applying insulation materials.
- B. Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

3.3 SCHEDULES

- A. Acceptable duct insulation materials and thicknesses are identified for each system. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Manufacturer shall validate and provide documentation indicated that schedule thickness meets ASHRAE 90.1 insulation requirements.
- C. Rectangular Sheet Metal, Installed Within Building Thermal Envelope:

Service	Insulation Spec No.	Thickness, Inches
Supply Air	DI-2	1-1/2
Return Air	DI-2	1-1/2
Exhaust Air/Relief Air	Not Required	N/A
Outdoor Air	DI-4	1-1/2

- D. Round Sheet Metal, Installed Within Building Thermal Envelope:

Service	Insulation Spec No.	Thickness, Inches
Supply Air	DI-2	1-1/2
Return Air	DI-2	1-1/2
Exhaust Air	Not Required	N/A

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Outdoor Air
Relief Air

DI-2
Not Required

1-1/2
N/A

END OF SECTION 23 07 13

SECTION 23 07 16**HVAC EQUIPMENT INSULATION****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Equipment insulation.
- B. Flexible removable and reusable blanket insulation.
- C. Covering.

1.2 RELATED REQUIREMENTS

- A. Division 01 - General Requirements
- B. Section 23 05 53 - Identification for HVAC Piping and Equipment.
- C. Section 23 21 13 - Hydronic Piping: Placement of hangers and hanger inserts.
- D. Section 23 21 14 - Hydronic Specialties.

1.3 REFERENCE STANDARDS

- A. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2014.
- B. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2013.
- C. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement; 2007 (Reapproved 2013).
- D. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2010.
- E. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2014.
- F. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2013.
- G. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type); 2013.
- H. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2014.
- I. ASTM C1695 - Standard Specification for Fabrication of Flexible Removable and Reusable Blanket Insulation for Hot Service; 2010 (Reapproved 2015).
- J. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.
- K. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2014.
- L. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for equipment scheduled.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

PART 2 PRODUCTS**2.1 REGULATORY REQUIREMENTS**

- A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.2 GLASS FIBER, FLEXIBLE

- A. Manufacturers:
 - 1. CertainTeed Corporation: www.certainteed.com/#sle.
 - 2. Johns Manville Corporation: www.jm.com/#sle.
 - 3. Knauf Insulation; Atmosphere Duct Wrap: www.knaufinsulation.com/#sle.
 - 4. Owens Corning Corporation: www.ocbuildingspec.com/#sle.
 - 5. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Insulation: ASTM C553; flexible, noncombustible.
 - 1. K Value: 0.36 at 75 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
 - 2. Maximum Service Temperature: 450 degrees F.
 - 3. Maximum Water Vapor Absorption: 5.0 percent by weight.
- C. Vapor Barrier Jacket: Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
 - 1. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 - 2. Secure with self-sealing longitudinal laps and butt strips.

2.3 FLEXIBLE REMOVABLE AND REUSABLE BLANKET INSULATION

- A. Manufacturers:
 - 1. Auburn Manufacturing Inc; Ever Green Cut 'n Wrap: www.auburnmfg.com/#sle.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Insulation: ASTM C553 Type V; flexible, noncombustible.
 - 1. Comply with ASTM C1695.
 - 2. K Value: 0.37 at 100 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
 - 3. Minimum Service Temperature: 32 degrees F.
 - 4. Maximum Service Temperature: 500 degrees F.
 - 5. Maximum Water Vapor Absorption: Less than 5.0 percent by weight.
 - 6. Color: Green.
 - 7. Weight: 7.65 oz per sq ft.
 - 8. Effective Thickness: 1.25 plus/minus 0.25 inch.

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2.4 GLASS FIBER, RIGID EI-2

- A. Manufacturer:
 - 1. CertainTeed Corporation: www.certainteed.com/#sle.
 - 2. Johns Manville Corporation: www.jm.com/#sle.
 - 3. Knauf Insulation; Earthwool Insulation Board: www.knaufinsulation.com/#sle.
 - 4. Owens Corning Corporation: www.ocbuildingspec.com/#sle.
- B. Insulation: ASTM C612 or ASTM C592; rigid, noncombustible.
 - 1. K Value: 0.25 at 75 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
 - 2. Maximum Service Temperature: 850 degrees F.
 - 3. Maximum Water Vapor Absorption: 5.0 percent by weight.
 - 4. Maximum Density: 8.0 lb/cu ft.
- C. Vapor Barrier Jacket:
 - 1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
 - 2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 - 3. Secure with self-sealing longitudinal laps and butt strips.
- D. Outdoor installation shall have white EPDM covering.

2.5 CELLULAR GLASS

- A. Manufacturer:
 - 1. Owens Corning Corporation: www.ocbuildingspec.com/#sle.

2.6 FLEXIBLE ELASTOMERIC CELLULAR INSULATION EI-1

- A. Manufacturer:
 - 1. Armacell LLC; ArmaFlex Ultra with FlameDefense: www.armacell.us/#sle.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1, in sheet form.
 - 1. Minimum Service Temperature: Minus 40 degrees F.
 - 2. Maximum Service Temperature: 220 degrees F.
 - 3. Connection: Waterproof vapor barrier adhesive.
- C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.
- D. Outdoor installation shall be covered with glass fiber mesh embedded in insulation adhesive and painted with insulation manufacturer's standard protective finish.

2.7 JACKETS

- A. Canvas Jacket: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire retardant lagging adhesive.
 - 1. Lagging Adhesive: Compatible with insulation.

PART 3 EXECUTION**3.1 EXAMINATION**

- A. Verify that equipment has been tested before applying insulation materials.

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- B. Verify that surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Factory Insulated Equipment: Do not insulate.
- C. Insulated equipment containing fluids below ambient temperature; insulate entire system.
- D. Fiber glass insulated equipment containing fluids below ambient temperature; provide vapor barrier jackets, factory-applied or field-applied. Finish with glass cloth and vapor barrier adhesive.
- E. For hot equipment containing fluids over 140 degrees F, insulate flanges and unions with removable sections and jackets.
- F. Fiber glass insulated equipment containing fluids above ambient temperature; provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Finish with glass cloth and adhesive.
- G. Cover glass fiber insulation with metal mesh and finish with heavy coat of insulating cement.
- H. Nameplates and ASME Stamps: Bevel and seal insulation around; do not insulate over.
- I. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation so it can be easily removed and replaced without damage.

3.3 SCHEDULE

- A. Acceptable insulation materials and thicknesses are identified for each system. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Manufacturer shall validate and provide documentation indicated that schedule thickness meets ASHRAE 90.1 insulation requirements.

Equipment	Insulation Spec. No.	Thickness, Inches
Air Separator, Hot	EI-2	2
Boiler Feedwater Tank	EI-2	2
Boiler Flue Pipe	EI-2	2
Cooling System Pumps	EI-2	2

- C. Heating Systems:
1. Pump Bodies:
 2. Air Separators:
 3. Expansion Tanks:

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- D. Cooling Systems:
 - 1. Pump Bodies:

END OF SECTION 23 07 16

SECTION 23 07 19**HVAC PIPING INSULATION****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Piping insulation.
- B. Flexible removable and reusable blanket insulation.
- C. Jackets and accessories.

1.2 RELATED REQUIREMENTS

- A. Division 01 - General Requirements
- B. Section 23 21 13 - Hydronic Piping: Placement of hangers and hanger inserts.

1.3 REFERENCE STANDARDS

- A. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2014.
- B. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric]; 2014.
- C. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2013.
- D. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement; 2007 (Reapproved 2013).
- E. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2010.
- F. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2014.
- G. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation; 2015.
- H. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel; 2008 (Reapproved 2013).
- I. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.
- J. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2014.
- K. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
- B. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

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1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years of documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

PART 2 PRODUCTS**2.1 REGULATORY REQUIREMENTS**

- A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.2 GLASS FIBER PI-1

- A. Manufacturers:
1. CertainTeed Corporation: www.certainteed.com/#sle.
 2. Johns Manville Corporation: www.jm.com/#sle.
 3. Owens Corning Corporation; Fiberglas Pipe Insulation ASJ: www.ocbuildingspec.com/#sle.
 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible.
1. K Value: ASTM C177, 0.24 at 75 degrees F.
 2. Maximum Service Temperature: 850 degrees F.
 3. Maximum Moisture Absorption: 0.2 percent by volume.
- C. Insulation: ASTM C547 and ASTM C795; semi-rigid, noncombustible, end grain adhered to jacket.
1. Maximum Service Temperature: 650 degrees F.
 2. Maximum Moisture Absorption: 0.2 percent by volume.
- D. Seams and Joints: Self-sealing (pressure sensitive) lap seams and matching butt strips.
- E. Fittings
1. Fiberglass batt inserts with premolded PVC jacket:
 - a. Properties: 0.28 maximum K at 75 degrees F. mean, 0 degrees F. to 450 degrees F. temperature range, FHC 25/50 fire hazard per ASTM E-84.
- F. For outdoor installations, insulation jacket shall be 20 mill PVC or 0.016 inch aluminum.
- G. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm-inches.
- H. Vapor Barrier Lap Adhesive: Compatible with insulation.
- I. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.

2.3 FLEXIBLE ELASTOMERIC CELLULAR INSULATION PI-2

- A. Manufacturers:
1. Aeroflex USA, Inc; Aerocel Stay-Seal with Protape (SSPT): www.aeroflexusa.com/#sle.
 2. Armacell LLC; ArmaFlex Ultra with FlameDefense: www.armacell.us/#sle.
 3. K-Flex USA LLC; K-Flex Titan: www.kflexusa.com/#sle.
 4. Substitutions: See Section 01 60 00 - Product Requirements.

- B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1; use molded tubular material wherever possible.
 - 1. Minimum Service Temperature: Minus 40 degrees F.
 - 2. Maximum Service Temperature: 180 degrees F.
 - 3. Connection: Waterproof vapor barrier adhesive.
- C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.
- D. Outdoor installation shall be covered with glass fiber mesh embedded in insulation adhesive and painted with insulation manufacturer's standard protective finish.

2.4 JACKETS

- A. Canvas Jacket: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire retardant lagging adhesive.
 - 1. Lagging Adhesive: Compatible with insulation.
- B. Aluminum Jacket: ASTM B209 (ASTM B209M) formed aluminum sheet.
 - 1. Thickness: 0.016 inch sheet.
 - 2. Finish: Smooth.
 - 3. Joining: Longitudinal slip joints and 2 inch laps.
 - 4. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
 - 5. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Test piping for design pressure, liquid tightness, and continuity prior to applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Insulated Pipes Conveying Fluids Below Ambient Temperature:
 - 1. Insulate entire system, including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
- C. Glass Fiber Insulated Pipes Conveying Fluids Below Ambient Temperature:
 - 1. Provide vapor barrier jackets, factory-applied or field-applied; secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
 - 2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.
- D. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
- E. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions at equipment.
- F. Glass Fiber Insulated Pipes Conveying Fluids Above Ambient Temperature:

1. Provide standard jackets, with or without vapor barrier, factory-applied, or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure-sensitive adhesive. Secure with outward clinch expanding staples.
 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
- G. Inserts and Shields:
1. Application: Piping 1-1/2 inches diameter or larger.
 2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
 3. Insert location: Between support shield and piping and under the finish jacket.
 4. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 5. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
- H. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, see Section 07 84 00.
- I. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor): Finish with canvas jacket sized for finish painting.
- J. Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping. Provide two coats of UV resistant finish for flexible elastomeric cellular insulation without jacketing.

3.3 SCHEDULE

Service	Temp. Range (F)	Insulation Spec. No.	Insulation Thickness - to 1-1/2" Pipe	Insulation Thickness - 2" Pipe	Insulation Thickness - 2-1/2 to 4" Pipe	Insulation Thickness - 5" and Larger Pipe
Chilled and Domestic Make-Up Water	45 to 65	PI-1	1	1-1/2	2	2-1/2
Hot Water	> 161	PI-1	1-1/2	2	2	2
Hot Water	100 to 160	PI-1	1-1/2	2	2	2
Refrigerant	Below 40	PI-2	1-1/2	1-1/2	1-1/2	1-1/2
Suction		PI-2	1-1/2	1-1/2	1-1/2	N/A
Condensate Drainage	35 to 70	PI-1	1	1	1	1

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- A. Heating Systems:
 - 1. Heating Water Supply and Return:
 - 2. Glycol Heating Supply and Return:
 - 3. Boiler Feed Water:
- B. Cooling Systems:
 - 1. Chilled Water:
 - 2. Glycol Cooling Supply and Return:
 - 3. Condensate Drains from Cooling Coils:
 - 4. Refrigerant Suction:
 - 5. Refrigerant Hot Gas:

END OF SECTION 23 07 19

SECTION 23 09 13**INSTRUMENTATION AND CONTROL DEVICES FOR HVAC****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Control panels.
- B. Control Valves:
 - 1. Ball valves and actuators.
 - 2. Electronic operators.
- C. Pressure independent valves and actuators.
- D. Dampers.
- E. Damper Operators:
 - 1. Electric operators.
- F. Humidistats:
 - 1. Room humidistats.
- G. Input/Output Sensors:
 - 1. Temperature sensors.
 - 2. Humidity sensors.
 - 3. Static pressure (air pressure) sensors.
 - 4. Equipment operation (current) sensors.
- H. Thermostats:
 - 1. Electric room thermostats.
 - 2. Low-limit temperature cutout switch (freezestat)
 - 3. Line voltage thermostats.
 - 4. Room thermostat accessories.
 - 5. Outdoor reset thermostats.
 - 6. Immersion thermostats.
 - 7. Airstream thermostats.
 - 8. Electric low limit duct thermostats.
 - 9. Electric high limit duct thermostats.
- I. Transmitters:
 - 1. Building static pressure transmitters.
 - 2. Temperature transmitters.
- J. Flow Sensors:
 - 1. Paddle type flow meters.

1.2 RELATED REQUIREMENTS

- A. Division 01 - General Requirements
- B. Section 23 21 13 - Hydronic Piping: Installation of control valves, flow switches, temperature sensor sockets, and gauge taps.
- C. Section 23 21 14 - Hydronic Specialties.

- D. Section 23 33 00 - Air Duct Accessories: Installation of automatic dampers.
- E. Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS

- A. AMCA 500-D - Laboratory Methods of Testing Dampers for Rating; 2012.
- B. ANSI/FCI 70-2 - Control Valve Seat Leakage; 2013.
- C. ASME B1.20.1 - Pipe Threads, General Purpose (Inch); 2013.
- D. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2013.
- E. ASTM B32 - Standard Specification for Solder Metal; 2008 (Reapproved 2014).
- F. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2014.
- G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
- H. NEMA DC 3 - Residential Controls - Electrical Wall-Mounted Room Thermostats; 2013.
- I. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2015.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Conduct a preinstallation meeting one week before starting work of this section; require attendance by all affected installers.
- B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.5 SUBMITTALS

- A. Listed manufacturers and series are for reference only and do not promote any single product. Series are provided for reference, and should not be used as an ordering model number. Accessories and options may be custom components purchased separately.
- B. Product Data: Provide manufacturer's catalog sheet for equipment indicating rough-in size, finish, and accessories. Manufacturer's data sheets on each item of equipment and device, marked up to identify the items to be used on the project.
- C. Product Data: Provide description and engineering data for each control system component. Include sizing as requested. Provide data for each system component and software module.
- D. Shop Drawings: Indicate complete operating data, system drawings, wiring diagrams, and written detailed operational description of sequences. Submit schedule of valves indicating size, flow, and pressure drop for each valve. For automatic dampers indicate arrangement, velocities, and static pressure drops for each system.
- E. Manufacturer's Instructions: Provide for all manufactured components.
- F. Operation and Maintenance Data: Include inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.
- G. Project Record Documents: Record actual locations of control components, including panels, thermostats, and sensors. Accurately record actual location of control components, including panels, thermostats, and sensors.

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- H. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.
- I. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 - 2. Extra Thermostats and Other Exposed Sensors: One of each type.

1.6 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS**2.1 MANUFACTURERS**

- A. Schnieder Electric.

2.2 EQUIPMENT - GENERAL

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

2.3 CONTROL PANELS

- A. Unitized cabinet type for each system under automatic control with relays and controls mounted in cabinet and temperature indicators, pressure gauges, pilot lights, push buttons and switches flush on cabinet panel face.
- B. NEMA 250, general purpose utility enclosures with enameled finished face panel.

2.4 CONTROL VALVES

- A. Ball Valves and Actuators:
 - 1. Manufacturers:
 - a. Belimo Aircontrols (USA), Inc: www.belimo.com/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
 - 2. Service: Use for hot water.
 - 3. Flow Characteristic: Include 2-way and 3-way diverting operation configured to fail normally closed (NC).
 - 4. Replacements in Kind: Provide pressure-independent type.
 - 5. Rangeability: 500 to 1.
 - 6. ANSI Rating: Class 150.
 - 7. Leakage: Class IV (0.1 percent of rated capacity) per ANSI/FCI 70-2.
 - 8. Body Size:
 - a. Under 2-1/2 inches:
 - 1) Connection: NPT.
 - 2) Materials:
 - (a) Body: Brass.
 - (b) Flanges: Ductile iron.
 - (c) Ball: Chrome-plated brass.
 - (d) Stem: Nickel-plated brass.
 - (e) Seat: Graphite-reinforced PTFE with EPDM O-Ring backing.
 - (f) Stem Seal: EPDM O-Rings.
 - (g) Flow Control Disk: Thermoplastic synthetic-resin.

- b. Service Temperature:
 - 1) Fluid Side: 0 to 284 degrees F liquid or 25 psig steam.
 - 2) Ambient Side: From minus 4 to 122 degrees F.
 - 9. Actuator Requirements:
 - a. Assembly: Factory-mounted.
 - b. Input: 0 to 5 VDC configured for proportional control.
 - c. Accessories: Provide with valve position indicator and manual override.
- B. Ball Valve:
 - 1. Bronze body, stainless steel, 3 piece, full port
 - a. Product:
 - 1) Substitutions: See Section 01 60 00 - Product Requirements.
 - 2. Hydronic Systems:
 - a. Rate for service pressure of 125 psig at 250 degrees F.
 - b. Stainless steel ball.
 - c. Size for 3 psig maximum pressure drop at design flow rate.
 - d. Three way valves shall have equal percentage characteristics, three way valves linear characteristics. Size two way valve operators to close valves against pump shut off head.
 - 3. Steam Systems:
 - a. Rate for service pressure of 125 psig at 250 degrees F.
 - b. Pressure drop across any steam valve at maximum flow shall be as shown on the Drawings.
 - c. Size for 10 psig inlet pressure and 5 psig pressure drop.
 - d. Valves shall have modified linear characteristics.
- C. Electronic Operators:
 - 1. Manufacturers:
 - a. Schneider Electric: www.schneider-electric.us/#sle.
 - 2. Valves shall spring return to normal position as indicated on freeze, fire, or temperature protection.
 - 3. Select operator for full shut off at maximum differential pressure.
 - 4. Coordinate voltages with installation and contractor responsible for wiring device.
 - 5. End switch.
 - 6. Fully modulating or 2-position as required.

2.5 DAMPERS

- A. Manufacturers:
 - 1. Ruskins Model CD-50.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Performance: Test in accordance with AMCA 500-D.
- C. Frames: Galvanized steel, welded or riveted with corner reinforcement, minimum 12 gauge, 0.1046 inch.
- D. Blades: Galvanized steel, maximum blade size 8 inches wide, 48 inches long, minimum 22 gauge, 0.0299 inch, attached to minimum 1/2 inch shafts with set screws.
- E. Blade Seals: Neoprene mechanically attached, field replaceable.
- F. Jamb Seals: Spring stainless steel.
- G. Leakage: Less than one percent based on approach velocity of 2000 ft per min and 4 inches wg.

- H. Maximum Pressure Differential: 6 inches wg.
- I. Temperature Limits: Minus 40 to 200 degrees F.

2.6 DAMPER OPERATORS

- A. General: Provide smooth proportional control with sufficient power for air velocities 20 percent greater than maximum design velocity and to provide tight seal against maximum system pressures. Provide spring return for two position control and for fail safe operation.
 - 1. Provide sufficient number of operators to achieve unrestricted movement throughout damper range.
- B. Electric Operators:
 - 1. Manufacturers:
 - a. Schneider Electric: www.schneider-electric.us/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
 - 2. Spring return, adjustable stroke motor having oil immersed gear train, with auxiliary end switch.

2.7 HUMIDISTATS

- A. Room Humidistats:
 - 1. Wall mounted, proportioning type.
 - 2. Throttling Range: Adjustable 2 percent relative humidity.
 - 3. Operating Range: 30 to 80 percent.
 - 4. Maximum Temperature: 110 degrees F.
 - 5. Cover: Set point indication.

2.8 INPUT/OUTPUT SENSORS

- A. Temperature Sensors:
 - 1. Manufacturers:
 - a. Schnieder Electric.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
 - 2. Use thermistor or RTD type temperature sensing elements with characteristics resistant to moisture, vibration, and other conditions consistent with the application without affecting accuracy and life expectancy.
 - 3. Construct RTD of nickel or platinum with base resistance of 1000 ohms at 70 degrees F.
 - 4. Temperature Sensing Device: Compatible with project DDC controllers.
 - 5. Performance Characteristics:
 - a. RTD:
 - 1) Room Sensor Accuracy: Plus/minus 0.50 degrees F minimum.
 - 2) Duct Averaging Accuracy: Plus/minus 0.50 degrees F minimum.
 - 3) Chilled Water Accuracy: Plus/minus 0.50 degrees F minimum.
 - 4) All Other Accuracy: Plus/minus 0.75 degrees F minimum.
 - 5) Range: Minus 40 degrees F through 220 degrees F minimum.
 - b. Thermistor:
 - 1) Accuracy (All): Plus/minus 0.36 degrees F minimum.
 - 2) Range: Minus 25 degrees F through 122 degrees F minimum.
 - 3) Heat Dissipation Constant: 2.7 mW per degree C.
 - c. Temperature Transmitter:
 - 1) Accuracy: 0.10 degree F minimum or plus/minus 0.20 percent of span.
 - 2) Output: 4 to 20 mA.

- d. Sensing Range:
 - 1) Provide limited range sensors if required to sense the range expected for a respective point.
 - e. Wire Resistance:
 - 1) Use appropriate wire size to limit temperature offset due to wire resistance to 1.0 degree F or use temperature transmitter when offset is greater than 1.0 degree F due to wire resistance.
 - 2) Compensate for wire resistance in software input definition when feature is available in the DDC controller.
 - f. Outside Air Sensors: Watertight inlet fitting shielded from direct rays of the sun.
 - g. Immersion Temperature Sensors: A sensor encased in a corrosion-resistant probe with an indoor junction box service entry body.
 - h. Room Security Sensors: Stainless steel cover plate with insulated back and security screws.
 - i. Room Temperature Sensors:
 - 1) Construct for wall box mounting.
 - 2) Provide the following:
 - (a) Setpoint reset slide switch with an adjustable temperature range.
 - (b) Individual heating/cooling setpoint slide switches.
 - (c) Momentary override request push button for activation of after-hours operation.
 - (d) Analog thermometer.
 - j. Room Temperature Sensors with Integral Digital Display:
 - 1) Construct for wall box.
 - 2) Provide a four button keypad with the following capabilities:
 - (a) Indication of space and outdoor temperatures.
 - (b) Setpoint adjustment to accommodate room setpoint.
 - (c) Manual occupancy override and indication of occupancy status.
 - k. Temperature Averaging Elements:
 - 1) Use on duct sensors for ductwork 10 sq ft or larger.
 - 2) Use averaging elements where prone to stratification with sensor length 8 ft.
 - 3) Provide for all mixed air and heating coil discharge sensors regardless of duct size.
 - l. Insertion Elements:
 - 1) Use in ducts not affected by temperature stratification or smaller than 11 sq inches.
 - 2) Provide dry type, insertion elements for liquids, installed in immersion wells, with minimum insertion length of 2.5 inches.
- B. Humidity Sensors:
- 1. Manufacturers:
 - a. Schnieder Electric.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- C. Static Pressure Sensors:
- 1. Unidirectional with ranges not exceeding 150 percent of maximum expected input.
 - 2. Temperature compensate with typical thermal error or 0.06 percent of full scale in temperature range of 40 to 100 degrees F.
 - 3. Accuracy: One percent of full scale with repeatability 0.3 percent.
 - 4. Output: 0 - 5 vdc with power at 12 to 28 vdc.
- D. Equipment Operation Sensors:
- 1. Status Inputs for Fans: Differential pressure switch with adjustable range of 0 to 5 inches wg.
 - 2. Status Inputs for Pumps: Differential pressure switch piped across pump with adjustable pressure differential range of 8 to 60 psi.

3. Status Inputs for Electric Motors: Current sensing relay with current transformers, adjustable and set to 175 percent of rated motor current.
4. Product:
 - a. Substitutions: See Section 01 60 00 - Product Requirements.
- E. Damper Position Indication: Potentiometer mounted in enclosure with adjustable crank arm assembly connected to damper to transmit 0 - 100 percent damper travel.
- F. Static Pressure (Air Pressure) Sensors:
 1. Manufacturers:
 - a. Schnieder Electric.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
 2. Unidirectional with ranges not exceeding 150 percent of maximum expected input.
 3. Temperature compensate with typical thermal error or 0.06 percent of full scale in temperature range of 40 to 100 degrees F.
 4. Accuracy: One percent of full scale with repeatability 0.3 percent.
 5. Output: 0 to 5 vdc with power at 12 to 28 vdc.
- G. Equipment Operation (Current) Sensors:
 1. Status Inputs for Fans: Differential pressure switch with adjustable range of 0 to 5 inches wg.
 2. Status Inputs for Pumps: Differential pressure switch piped across pump with adjustable pressure differential range of 8 to 60 psi.
 3. Status Inputs for Electric Motors: Current sensing relay with current transformers, adjustable and set to 175 percent of rated motor current.

2.9 THERMOSTATS

- A. Electric Room Thermostats:
 1. Manufacturers:
 - a. Schnieder Electric.
 2. Type: NEMA DC 3, 24 volts, with setback/setup temperature control.
 3. Service: Cooling and Heating; one step cooling and two step heating.
 4. Covers: Locking with set point adjustment, with thermometer.
- B. Low-Limit Temperature Cutout Switch (low-limit thermostat or freezestat):
 1. Manufacturers:
 - a. Honeywell International, Inc: buildingcontrols.honeywell.com/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
 2. Configuration: Digital module tied to sensor-assembly.
 3. Sensing Length: 4 feet.
 4. Setpoint Adjust: Slider.
 5. Switch Type: SPDT, snap-action, form C in dust-protected enclosure.
 6. Mounting: Locate on cooling coil intake side.
 7. Field Interface: Connect load line-voltage to stater.
 8. Electrical Rating: Pilot duty, 125 VA at 125 to 600 VAC.
- C. Line Voltage Thermostats:
 1. Integral manual On/Off/Auto selector switch, single or two pole as required.
 2. Dead Band: Maximum 2 degrees F.
 3. Cover: Locking with set point adjustment, with thermometer.
- D. Room Thermostat Accessories:
 1. Thermostat Covers: Brushed aluminum.

2. Insulating Bases: For thermostats located on exterior walls.
 3. Thermostat Guards: Metal mounted on separate base.
 4. Adjusting Key: As required for device.
- E. Outdoor Reset Thermostats:
1. Remote bulb or bimetal rod and tube type, proportioning action with adjustable throttling range, adjustable setpoint.
 2. Scale range: Minus 10 to 70 degrees F.
- F. Immersion Thermostats:
1. Remote bulb or bimetallic rod and tube type, proportional action with adjustable setpoint and adjustable throttling range.
- G. Airstream Thermostats:
1. Remote bulb or bimetallic rod and tube type, proportional action with adjustable setpoint in middle of range and adjustable throttling range.
 2. Averaging service remote bulb element: 7.5 feet.
- H. Electric Low Limit Duct Thermostats:
1. Snap acting, single pole, single throw, automatic reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below setpoint.
 2. Bulb length: Minimum 20 feet.
 3. Provide one thermostat for every 20 sq ft of coil surface.

2.10 TRANSMITTERS

- A. Building Static Pressure Transmitters:
1. One pipe, differential type with temperature compensation, scale range 0.01 to 6.0 inch wg positive or negative, and sensitivity of 0.0005 inch wg. Transmit electronic signal to receiver with matching scale range.
- B. Pressure Transmitters:
1. One pipe direct acting indicating type for gas, liquid, or steam service, range suitable for system, proportional electronic output.
- C. Temperature Transmitters:
1. One pipe, directly proportional output signal to measured variable, linearity within plus or minus 1/2 percent of range for 200 degrees F span and plus or minus 1 percent for 50 degrees F span, with 50 degrees F. temperature range, compensated bulb, averaging capillary, or rod and tube operation on 20 psig input pressure and 3 to 15 psig output.
- D. Humidity Transmitters:
1. One pipe, directly proportioned output signal to measured variable, linearity within plus or minus 1 percent for 70 percent relative humidity span, capable of withstanding 95 percent relative humidity without loss of calibration.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that systems are ready to receive work.
- C. Beginning of installation means installer accepts existing conditions.

- D. Sequence work to ensure installation of components is complementary to installation of similar components in other systems.
- E. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.
- F. Ensure installation of components is complementary to installation of similar components.
- G. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Coordinate voltage and power requirements of each device with installation and contractor responsible for wiring device.
- C. Check and verify location of thermostats, humidistats, and exposed control sensors with plans and room details before installation. Locate 42 inches above finished floor. Align with lighting switches and humidistats. Refer to Section 26 27 26.
- D. Mount freeze protection thermostats using flanges and element holders.
- E. Mount outdoor reset thermostats and outdoor sensors indoors with sensing elements outdoors with sun shield.
- F. Provide separable sockets for liquids and flanges for air bulb elements.
- G. Provide valves with position indicators and with pilot positioners where sequenced with other controls.
- H. Provide separate steam valves for each bank of coils. Provide two valves in parallel where steam load exceeds 1500 lb per hr with 1/3 to 2/3 load capacities sequenced with smaller valve opening first.
- I. Provide isolation (two position) dampers of parallel blade construction.
- J. Actuators
 - 1. Install in an accessible location, with room for actuator removal and service. Adjust the actuator to provide tight shutoff. Provide stem indicator and adjust to indicate proper travel.
 - 2. Install damper motors on outside of duct in warm areas. Do not install motors in locations at outdoor temperatures.
- K. Mount control panels adjacent to associated equipment on vibration free walls or free standing angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide engraved plastic nameplates for instruments and controls inside cabinet and engraved plastic nameplates on cabinet face.
- L. Install "on/off/auto" selector switches to override automatic interlock controls when switch is in "on" position.
- M. Power
 - 1. Power feeds for the building automation system, control panels or to operate the controls shall be fed from a 120 volt panel.
 - 2. Any breaker indicated as "Building Controls" is available for the controls to furnish and install the associated wiring and conduit in accordance with Section 26 05 83 - Wiring Connections. Electrical

material and installation shall be in accordance with appropriate requirements of Division 26. The contractor shall extend power wiring to the location required by the controls device.

3. If additional circuits or power is required for the Control system, it is the contractors responsibility to provide the breaker, wiring and conduit in accordance with Section 26 05 83 - Wiring Connections. Electrical material and installation shall be in accordance with appropriate requirements of Division 26. The contractor shall extend power wiring to the location required by the controls device.

N. Wire and Cable

1. Provide conduit and electrical wiring in accordance with Section 26 05 83. Electrical material and installation shall be in accordance with appropriate requirements of .
2. Wire and Cable shall be installed without splices between control devices and in accordance with NFPA 70 and NFPA 90A.
3. All wire-to-device connections shall be made at a terminal block or terminal strip. All wire to wire connections shall be at a terminal block.
4. Instrumentation grounding shall be installed per the device manufacturer's instructions and as necessary to prevent ground loops, noise, and surges from adversely affecting operation of the system.
5. Test installed ground rods as specified in IEEE 142. Cables and conductor wires shall be tagged at both ends, with the identifier shown on the shop drawings.

O. Electric Low Limit Duct Thermostat:

1. A temperature limit switch (freezestat) shall be provided to sense the temperature at all outside air connections to mechanical equipment.
2. A temperature limit switch (freezestat) shall be provided to sense the temperature at all water to air heat transfer mechanical equipment.
3. A sufficient number of temperature limit switches (freezestats) shall be installed to provide complete coverage of the duct or coil section.
4. Manual reset limit switches shall be installed in approved, accessible locations where they can be reset easily.
5. The temperature limit switch (freezestat) sensing element shall be installed in a serpentine pattern and in accordance with the manufacturer's installation instructions.

P. Duct Static Pressure sensor

1. The duct static pressure sensing tap shall be located at 75% to 100% of the distance between the first and last air terminal units.
2. If the transmitter output is a 4-20 mA or 0-10Vdc signal, the transmitter shall be located in the same enclosure as the air handling unit (AHU) / Fan or equipment controller for the equipment serving the duct system.

3.3 ADJUSTING

- A. The AMD shall not be adjusted to match field measurements without approval from the consulting mechanical engineer when installations meet or exceed manufacturer's suggested placement guidelines. Field adjustment, when required shall be accomplished using transmitter firmware that calculates adjustment gain and offset coefficients based on one or two reference measurements.

3.4 MAINTENANCE

- A. See Section 01 70 00 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.
- B. Provide service and maintenance of control system for one year from Date of Substantial Completion.

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- C. Provide complete service of controls systems, including call backs, and submit written report of each service call.
- D. In addition to normal service calls, make minimum of 2 complete normal inspections of approximately 8 hours duration to inspect, calibrate, and adjust controls.

3.5 START-UP

- A. Perform all startup and commissioning for a complete installation.

3.6 TRAINING

- A. Perform 40 hours training service including three 8 hour on site sessions.

END OF SECTION 23 09 13

SECTION 23 09 23**DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. System description.
- B. Operator interface.
- C. Controllers.
- D. Power supplies and line filtering.
- E. System software.
- F. Controller software.
- G. HVAC control programs.

1.2 RELATED REQUIREMENTS

- A. Division 01 - General Requirements
- B. Section 23 09 13 - Instrumentation and Control Devices for HVAC.
- C. Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS

- A. ASHRAE Std 135 - BACnet - A Data Communication Protocol for Building Automation and Control Networks; 2012.
- B. IEEE 802.11 - IEEE Standard for Information Technology--Telecommunications and Information Exchange Between Systems Local and Metropolitan Area Networks--Specific Requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications ; 2016.
- C. IEEE 802.15.4 - IEEE Standard for Low-Rate Wireless Networks; 2015.
- D. MIL-STD-810 - Environmental Engineering Considerations and Laboratory Tests; Revision G, 2014.
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. UL (DIR) - Online Certifications Directory; current listings at database.ul.com.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.
- B. Pre-submittal Meeting: Two weeks prior to furnishing submittal.

1.5 SUBMITTALS

- A. Within 10 days of award of contract, submit controls installation team qualifications package. Package shall include the following information:

1. Installation Contractor's name.
 2. Installation Contractor's address.
 3. Installation Contractor's field representative.
 4. Installation Contractor's designer.
 5. Installation Contractor's programmer.
 6. Installation Contractor's sub-contractor.
 7. Components manufacturer for controllers.
 8. Components manufacturer for sensors.
 9. System architecture diagram.
 10. System communication language.
 11. Installing Contractor's standard 2 year service agreement for proposed system.
 12. Estimate cost for 2 year service agreement.
- B. It is the Contractor's responsibility to schedule with the Engineer a pre-submittal meeting. This meeting will take place at the location chosen by the Engineer at a time agreed to by the Engineer. During this meeting the controls vendor shall present the controls system.
1. Cover Sheet/Title Sheet with the project name and date of this meeting on the sheet.
 2. Index and Legend.
 3. Communications riser to date and device addressing scheme.
 4. System Schematic: 1 for each system.
 5. Sequence of Operation: 1 for each system.
 6. Valve and Damper schedules.
 7. Product Data Sheets: This shall include at least a list of the controllers and devices to be used. The "list" could be a "combined BOM", and then submit Product Data Sheets for just the new or not-common devices. (The BAS Shop Drawings Submittal (for Approval) will still include Product Data Sheets for ALL the materials on the project, as these are important for future reference).
- C. Listed manufacturers and series are for reference only and do not promote any single product. Series are provided for reference, and should not be used as an ordering model number. Accessories and options may be custom components purchased separately.
- D. Product Data: Provide manufacturer's catalog sheet for equipment indicating rough-in size, finish, and accessories. Manufacturer's data sheets on each item of equipment and device, marked up to identify the items to be used on the project.
- E. Product Data: Provide data for each system component and software module.
- F. Shop Drawings:
1. Indicate trunk cable schematic showing programmable control unit locations, and trunk data conductors.
 2. List connected data points, including connected control unit and input device.
 3. Indicate system graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations. Provide demonstration digital media containing graphics.
 4. Show system configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
 5. Indicate description and sequence of operation of operating, user, and application software.
- G. Manufacturer's Instructions: Indicate manufacturer's installation instructions for all manufactured components.
- H. Designer's Qualification Statement.
- I. Manufacturer's Qualification Statement.

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- J. Installer's Qualification Statement.
- K. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors.
 - 1. Revise shop drawings to reflect actual installation and operating sequences.
 - 2. Include submittals data in final "Record Documents" form.
- L. Operation and Maintenance Data:
 - 1. Include interconnection wiring diagrams complete field installed systems with identified and numbered, system components and devices.
 - 2. Include keyboard illustrations and step-by-step procedures indexed for each operator function.
 - 3. Include inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
- M. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.6 QUALITY ASSURANCE

- A. Perform work in accordance with NFPA 70.
- B. Designer Qualifications: Perform design of system using manufacturer's software under direct supervision of a Professional Engineer experienced in design of this type of work and licensed in Commonwealth of Pennsylvania.
- C. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years of documented experience.
- D. Installer Qualifications: Company specializing in performing work of the type specified and with minimum three years of documented experience.
- E. Installer Qualifications: Company specializing in performing the work of this section with minimum five years experience.
- F. Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for purpose specified and indicated.

1.7 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Correct defective Work within a two year period after Substantial Completion.
- C. Provide five year manufacturer's warranty for field programmable micro-processor based units.

1.8 PROTECTION OF SOFTWARE RIGHTS

- A. Prior to delivery of software, the Owner and the party providing the software will enter into a software license agreement with provisions for the following:
 - 1. Limiting use of software to equipment provided under these specifications.
 - 2. Limiting copying.
 - 3. Preserving confidentiality.

PART 2 PRODUCTS**2.1 MANUFACTURERS**

- A. Schneider Electric: www.schneider-electric.us/#sle.
- B. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 SYSTEM DESCRIPTION

- A. Automatic temperature control field monitoring and control system using field programmable micro-processor based units with communications to Building Management System.
- B. Base system on distributed system of fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment on token passing network, with central and remote hardware, software, and interconnecting wire and conduit.
- C. Include computer software and hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.
- D. Controls for variable air volume terminals, radiation, reheat coils, unit heaters, fan coils, and the like when directly connected to the control units.
- E. Provide control systems consisting of thermostats, control valves, dampers and operators, indicating devices, interface equipment and other apparatus and accessories required to operate mechanical systems, and to perform functions specified.
- F. Include installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.

2.3 OPERATOR INTERFACE

- A. PC Based Work Station:
 - 1. Resides on high speed network with building controllers.
 - 2. Connected to server for full access to all system information.
- B. Workstation, controllers, and control backbone to communicate using BACnet protocol and addressing.
- C. BACnet protocol to comply with ASHRAE Std 135.

2.4 CONTROLLERS

- A. Building Controllers:
 - 1. General:
 - a. Manage global strategies by one or more, independent, standalone, microprocessor based controllers.
 - b. Provide sufficient memory to support controller's operating system, database, and programming requirements.
 - c. Share data between networked controllers.
 - d. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allowing for central monitoring and alarms.
 - e. Utilize real-time clock for scheduling.
 - f. Continuously check processor status and memory circuits for abnormal operation.
 - g. Controller to assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.

- h. Communication with other network devices to be based on assigned protocol.
 - 2. Communication:
 - a. Perform routing when connected to a network of custom application and application specific controllers.
 - b. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
 - 3. External Input-Output (I-O) Data Bus:
 - a. Input only modules.
 - b. Output only modules.
 - c. Variable frequency drives (VFD's).
 - d. Universal I-O module (configurable).
 - 4. Anticipated Environmental Ambient Conditions:
 - a. Outdoors and/or in Wet Ambient Conditions:
 - 1) Mount within waterproof enclosures.
 - 2) Rated for operation at 40 to 150 degrees F.
 - b. Conditioned Space:
 - 1) Mount within dustproof enclosures.
 - 2) Rated for operation at 32 to 120 degrees F.
 - 5. Local Keypad and Display for each Controller:
 - a. Use for interrogating and editing data.
 - b. System security password prevents unauthorized use.
 - 6. Provisions for Serviceability:
 - a. Diagnostic LEDs for power, communication, and processor.
 - b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
 - 7. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
 - 8. Power and Noise Immunity:
 - a. Maintain operation at 90 to 110 percent of nominal voltage rating.
 - b. Perform orderly shutdown below 80 percent of nominal voltage.
 - c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet.
- B. Custom Application Controllers:
 - 1. General:
 - a. Provide sufficient memory to support controller's operating system, database, and programming requirements.
 - b. Share data between networked, microprocessor based controllers.
 - c. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allowing for central monitoring and alarms.
 - d. Utilize real-time clock for scheduling.
 - e. Continuously check processor status and memory circuits for abnormal operation.
 - f. Controller to assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.
 - g. Communication with other network devices to be based on assigned protocol.
 - 2. Communication:
 - a. Controller to reside on a BACnet network using MS/TP Data Link/Physical layer protocol.
 - b. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
 - 3. Anticipated Environmental Ambient Conditions:

- a. Outdoors and/or in Wet Ambient Conditions:
 - 1) Mount within waterproof enclosures.
 - 2) Rated for operation at 40 to 150 degrees F.
 - b. Conditioned Space:
 - 1) Mount within dustproof enclosures.
 - 2) Rated for operation at 32 to 120 degrees F.
 - 4. Provisions for Serviceability:
 - a. Diagnostic LED's for power, communication, and processor.
 - b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
 - 5. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
 - 6. Power and Noise Immunity:
 - a. Maintain operation at 90 to 110 percent of nominal voltage rating.
 - b. Perform orderly shutdown below 80 percent of nominal voltage.
 - c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet.
- C. Application Specific Controllers:
 - 1. General:
 - a. Not fully user programmable, microprocessor based controllers dedicated to control specific equipment.
 - b. Customized for operation within the confines of equipment served.
 - c. Communication with other network devices to be based on assigned protocol.
 - 2. Communication:
 - a. Controller to reside on a BACnet network using MS/TP Data Link/Physical layer protocol.
 - b. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
 - 3. Anticipated Environmental Ambient Conditions:
 - a. Outdoors and/or in Wet Ambient Conditions:
 - 1) Mount within waterproof enclosures.
 - 2) Rated for operation at 40 to 150 degrees F.
 - b. Conditioned Space:
 - 1) Mount within dustproof enclosures.
 - 2) Rated for operation at 32 to 120 degrees F.
 - 4. Provisions for Serviceability:
 - a. Diagnostic LEDs for power, communication, and processor.
 - b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
 - 5. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
 - 6. Power and Noise Immunity:
 - a. Maintain operation at 90 to 110 percent of nominal voltage rating.
 - b. Perform orderly shutdown below 80 percent of nominal voltage.
 - c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 3 feet.
 - 7. Smart Sensor (SS):
 - a. Features: Built-in display and cool-warm adjust slider or knob.
 - b. Inputs: 3-universal (configurable).
 - c. Output: 4-externally power binary.
 - d. Occupancy Feedback: Alphanumeric display with changeable background color.

- e. Temperature Sensor: Platinum, 1,000 ohms RTD element inside insulated thermoplastic enclosure.
 - f. Communications Protocol: BACnet MS/TP per ASHRAE Std 135.
 - g. Certification: BACnet Testing Laboratory (BTL) certified device listed under the BACnet Smart Sensor (B-SS) device profile in compliance with ASHRAE Std 135.
- D. Input/Output Interface:
- 1. Hardwired inputs and outputs tie into the DDC system through building, custom application, or application specific controllers.
 - 2. All Input/Output Points:
 - a. Protect controller from damage resulting from any point short-circuiting or grounding and from voltage up to 24 volts of any duration.
 - b. Provide universal type for building and custom application controllers where input or output is software designated as either binary or analog type with appropriate properties.
 - 3. Binary Inputs:
 - a. Allow monitoring of On/Off signals from remote devices.
 - 4. Pulse Accumulation Input Objects: Conform to all requirements of binary input objects.
 - 5. Analog Inputs:
 - a. Allow for monitoring of low voltage 0 to 10 VDC, 4 to 20 mA current, or resistance signals (thermistor, RTD).
 - b. Compatible with and field configurable to commonly available sensing devices.
 - 6. Binary Outputs:
 - a. Used for On/Off operation or a pulsed low-voltage signal for pulse width modulation control.
 - b. Outputs provided with three position (On/Off/Auto) override switches.
 - c. Status lights for building and custom application controllers to be selectable for normally open or normally closed operation.
 - 7. Analog Outputs:
 - a. Monitoring signal provides a 0 to 10 VDC or a 4 to 20 mA output signal for end device control.
 - b. Provide status lights and two position (AUTO/MANUAL) switch for building and custom application controllers with manually adjustable potentiometer for manual override on building and custom application controllers.
 - 8. Tri State Outputs:
 - a. Coordinate two binary outputs to control three point, floating type, electronic actuators without feedback.
 - b. Limit the use of three point, floating devices to zone and terminal unit control applications.
 - 1) VAV terminal units.
 - 2) Duct mounted heating coils.
 - 3) Zone dampers.
 - 4) Radiation.
 - c. Control algorithms run the zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.
 - 9. System Object Capacity:
 - a. System size to be expandable to twice the number of input output objects required by providing additional controllers, including associated devices and wiring.
 - b. Hardware additions or software revisions for the installed operator interfaces are not to be required for future, system expansions.

2.5 POWER SUPPLIES AND LINE FILTERING

- A. Power Supplies:

1. Provide UL listed control transformers with Class 2 current limiting type or over-current protection in both primary and secondary circuits for Class 2 service as required by the NEC.
 2. Limit connected loads to 80 percent of rated capacity.
 3. Match DC power supply to current output and voltage requirements.
 4. Unit to be full wave rectifier type with output ripple of 5.0 mV maximum peak to peak.
 5. Regulation to be 1 percent combined line and load with 100 microsecond response time for 50 percent load changes.
 6. Provide over-voltage and over-current protection to withstand a 150 percent current overload for 3 seconds minimum without trip-out or failure.
 7. Operational Ambient Conditions: 32 to 120 degrees F.
 8. EM/RF meets FCC Class B and VDE 0871 for Class B and MIL-STD-810 for shock and vibration.
 9. Line voltage units UL recognized and CSA approved.
- B. Power Line Filtering:
1. Provide external or internal transient voltage and surge suppression component for all workstations and controllers.
 2. Minimum Surge Protection Attributes:
 - a. Dielectric strength of 1000 volts minimum.
 - b. Response time of 10 nanoseconds or less.
 - c. Transverse mode noise attenuation of 65 dB or greater.
 - d. Common mode noise attenuation of 150 dB or greater at 40 to 100 Hz.

2.6 LOCAL AREA NETWORK (LAN)

- A. Provide communication between control units over local area network (LAN).
- B. LAN Capacity: Not less than 60 stations or nodes.
- C. Break in Communication Path: Alarm and automatically initiate LAN reconfiguration.
- D. LAN Data Speed: Minimum 19.2 Kb.
- E. Communication Techniques: Allow interface into network by multiple operation stations and by auto-answer/auto-dial modems. Support communication over telephone lines utilizing modems.
- F. Transmission Median: Fiber optic or single pair of solid 24 gauge twisted, shielded copper cable.
- G. Network Support: Time for global point to be received by any station, shall be less than 3 seconds. Provide automatic reconfiguration if any station is added or lost. If transmission cable is cut, reconfigure two sections with no disruption to system's operation, without operator intervention.

2.7 SYSTEM SOFTWARE

- A. Operating System:
1. Concurrent, multi-tasking capability.
 - a. Common Software Applications Supported: Microsoft Excel.
 2. System Graphics:
 - a. Allow up to 10 graphic screens, simultaneously displayed for comparison and monitoring of system status.
 - b. Animation displayed by shifting image files based on object status.
 - c. Provide method for operator with password to perform the following:
 - 1) Move between, change size, and change location of graphic displays.
 - 2) Modify on-line.
 - 3) Add, delete, or change dynamic objects consisting of:

- (a) Analog and binary values.
 - (b) Dynamic text.
 - (c) Static text.
 - (d) Animation files.
- 3. Custom Graphics Generation Package:
 - a. Create, modify, and save graphic files and visio format graphics.
 - b. HTML graphics to support web browser compatible formats.
 - c. Capture or convert graphics from AutoCAD.
- 4. Standard HVAC Graphics Library:
 - a. HVAC Equipment:
 - 1) Boilers.
 - 2) Air Handlers.
 - 3) Terminal HVAC Units.
 - 4) Fan Coil Units.
 - b. Ancillary Equipment:
 - 1) Fans.
 - 2) Pumps.
 - 3) Coils.
 - 4) Valves.
 - 5) Piping.
 - 6) Dampers.
 - 7) Ductwork.
 - c. File Format Compatible with Graphics Generation Package Program.
- B. Workstation System Applications:
 - 1. Automatic System Database Save and Restore Functions:
 - a. Current database copy of each Building Controller is automatically stored on hard disk.
 - b. Automatic update occurs upon change in any system panel.
 - c. In the event of database loss in any system panel, the first workstation to detect the loss automatically restores the database for that panel unless disabled by the operator.
 - 2. Manual System Database Save and Restore Functions by Operator with Password Clearance:
 - a. Save database from any system panel.
 - b. Clear a panel database.
 - c. Initiate a download of a specified database to any system panel.
 - 3. Software provided allows system configuration and future changes or additions by operators under proper password protection.
 - 4. On-line Help:
 - a. Context-sensitive system assists operator in operation and editing.
 - b. Available for all applications.
 - c. Relevant screen data provided for particular screen display.
 - d. Additional help available via hypertext.
 - 5. Security:
 - a. Operator log-on requires user name and password to view, edit, add, or delete data.
 - b. System security selectable for each operator.
 - c. System supervisor sets passwords and security levels for all other operators.
 - d. Operator passwords to restrict functions accessible to viewing and/or changing system applications, editor, and object.
 - e. Automatic, operator log-off results from keyboard or mouse inactivity during user-adjustable, time period.
 - f. All system security data stored in encrypted format.
 - 6. System Diagnostics:

- a. Operations Automatically Monitored:
 - 1) Workstations.
 - 2) Printers.
 - 3) Modems.
 - 4) Network connections.
 - 5) Building management panels.
 - 6) Controllers.
- b. Device failure is annunciated to the operator.
- 7. Alarm Processing:
 - a. All system objects are configurable to "alarm in" and "alarm out" of normal state.
 - b. Configurable Objects:
 - 1) Alarm limits.
 - 2) Alarm limit differentials.
 - 3) States.
 - 4) Reactions for each object.
- 8. Alarm Messages:
 - a. Descriptor: English language.
 - b. Recognizable Features:
 - 1) Source.
 - 2) Location.
 - 3) Nature.
- 9. Configurable Alarm Reactions by Workstation and Time of Day:
 - a. Logging.
 - b. Printing.
 - c. Starting programs.
 - d. Displaying messages.
 - e. Dialing out to remote locations.
 - f. Paging.
 - g. Providing audible annunciation.
 - h. Displaying specific system graphics.
- 10. Custom Trend Logs:
 - a. Definable for any data object in the system including interval, start time, and stop time.
 - b. Trend Data:
 - 1) Sampled and stored on the building controller panel.
 - 2) Archivable on hard disk.
 - 3) Retrievable for use in reports, spreadsheets and standard database programs.
 - 4) Archival on LAN accessible storage media including hard disk, tape, Raid array drive, and virtual cloud environment.
 - 5) Protected and encrypted format to prevent manipulation, or editing of historical data and event logs.
- 11. Alarm and Event Log:
 - a. View all system alarms and change of states from any system location.
 - b. Events listed chronologically.
 - c. Operator with proper security acknowledges and clears alarms.
 - d. Alarms not cleared by operator are archived to the workstation hard disk.
- 12. Object, Property Status and Control:
 - a. Provide a method to view, edit if applicable, the status of any object and property in the system.
 - b. Status Available by the Following Methods:
 - 1) Menu.

- 2) Graphics.
 - 3) Custom Programs.
- 13. Reports and Logs:
 - a. Reporting Package:
 - 1) Allows operator to select, modify, or create reports.
 - 2) Definable as to data content, format, interval, and date.
 - 3) Archivable to hard disk.
 - b. Real-time logs available by type or status such as alarm, lockout, normal, etc.
 - c. Stored on hard disk and readily accessible by standard software applications, including spreadsheets and word processing.
 - d. Set to be printed on operator command or specific time(s).
- 14. Reports:
 - a. Standard:
 - 1) Objects with current values.
 - 2) Current alarms not locked out.
 - 3) Disabled and overridden objects, points and SNVTs.
 - 4) Objects in manual or automatic alarm lockout.
 - 5) Objects in alarm lockout currently in alarm.
 - 6) Logs:
 - (a) Alarm History.
 - (b) System messages.
 - (c) System events.
 - (d) Trends.
 - b. Custom:
 - 1) Daily.
 - 2) Weekly.
 - 3) Monthly.
 - 4) Annual.
 - 5) Time and date stamped.
 - 6) Title.
 - 7) Facility name.
 - c. Tenant Override:
 - 1) Monthly report showing total, requested, after-hours HVAC and lighting services on a daily basis for each tenant.
 - 2) Annual report showing override usage on a monthly basis.
- C. Workstation Applications Editors:
 - 1. Provide editing software for each system application at PC workstation.
 - 2. Downloaded application is executed at controller panel.
 - 3. Full screen editor for each application allows operator to view and change:
 - a. Configuration.
 - b. Name.
 - c. Control parameters.
 - d. Set-points.
 - 4. Scheduling:
 - a. Monthly calendar indicates schedules, holidays, and exceptions.
 - b. Allows several related objects to be scheduled and copied to other objects or dates.
 - c. Start and stop times adjustable from master schedule.
 - 5. Custom Application Programming:
 - a. Create, modify, debug, edit, compile, and download custom application programming during operation and without disruption of all other system applications.

- b. Programming Features:
 - 1) English oriented language, based on BASIC, FORTRAN, C, or PASCAL syntax allowing for free form programming.
 - 2) Alternative language graphically based using appropriate function blocks suitable for all required functions and amenable to customizing or compounding.
 - 3) Insert, add, modify, and delete custom programming code that incorporates word processing features such as cut/paste and find/replace.
 - 4) Allows the development of independently, executing, program modules designed to enable and disable other modules.
 - 5) Debugging/simulation capability that displays intermediate values and/or results including syntax/execution error messages.
 - 6) Support for conditional statements (IF/THEN/ELSE/ELSE-F) using compound Boolean (AND, OR, and NOT) and/or relations (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.
 - 7) Support for floating-point arithmetic utilizing plus, minus, divide, times, square root operators; including absolute value; minimum/maximum value from a list of values for mathematical functions.
 - 8) Language consisting of resettable, predefined, variables representing time of day, day of the week, month of the year, date; and elapsed time in seconds, minutes, hours, and days where the variable values can be used in IF/THEN comparisons, calculations, programming statement logic, etc.
 - 9) Language having predefined variables representing status and results of the system software enables, disables, and changes the set points of the controller software.

2.8 CONTROLLER SOFTWARE

- A. All applications reside and operate in the system controllers and editing of all applications occurs at the operator workstation.
- B. System Security:
 - 1. User access secured via user passwords and user names.
 - 2. Passwords restrict user to the objects, applications, and system functions as assigned by the system manager.
 - 3. User Log On/Log Off attempts are recorded.
 - 4. Automatic Log Off occurs following the last keystroke after a user defined delay time.
- C. Object or Object Group Scheduling:
 - 1. Weekly Schedules Based on Separate, Daily Schedules:
 - a. Include start, stop, optimal stop, and night economizer.
 - b. 10 events maximum per schedule.
 - c. Start/stop times adjustable for each group object.
 - 2. Exception Schedules:
 - a. Based on any day of the year.
 - b. Defined up to one year in advance.
 - c. Automatically discarded and replaced with standard schedule for that day of the week upon execution.
 - 3. Holiday or Special Schedules:
 - a. Capability to define up to 99 schedules.
 - b. Repeated annually.
 - c. Length of each period is operator defined.
- D. Provide standard application for equipment coordination and grouping based on function and location to be used for scheduling and other applications.

- E. Alarms:
 - 1. Binary object is set to alarm based on the operator specified state.
 - 2. Analog object to have high/low alarm limits.
 - 3. All alarming is capable of being automatically and manually disabled.
 - 4. Alarm Reporting:
 - a. Operator determines action to be taken for alarm event.
 - b. Alarms to be routed to appropriate workstation.
 - c. Reporting Options:
 - 1) Start programs.
 - 2) Print.
 - 3) Logged.
 - 4) Custom messaging.
 - 5) Graphical displays.
- F. Maintenance Management: System monitors equipment status and generates maintenance messages based upon user-designated run-time limits.
- G. Sequencing: Application software based upon specified sequences of operation.
- H. PID Control Characteristics:
 - 1. Direct or reverse action.
 - 2. Anti-windup.
 - 3. Calculated, time-varying, analog value, positions an output or stages a series of outputs.
 - 4. User selectable controlled variable, set-point, and PED gains.
- I. Staggered Start Application:
 - 1. Prevents all controlled equipment from simultaneously restarting after power outage.
 - 2. Order of equipment startup is user selectable.
- J. Anti-Short Cycling:
 - 1. All binary output objects protected from short-cycling.
 - 2. Allows minimum on-time and off-time to be selected.
- K. On-Off Control with Differential:
 - 1. Algorithm allows binary output to be cycled based on a controlled variable and set-point.
 - 2. Algorithm to be direct-acting or reverse-acting incorporating an adjustable differential.
- L. Run-Time Totalization:
 - 1. Totalize run-times for all binary input objects.
 - 2. Provides operator with capability to assign high run-time alarm.

2.9 HVAC CONTROL PROGRAMS

- A. General:
 - 1. Support Inch-pounds and SI (metric) units of measurement.
 - 2. Identify each HVAC Control system.
- B. Supply Air Reset:
 - 1. Monitor heating and cooling loads in building spaces, terminal reheat systems, both hot deck and cold deck temperatures on dual duct and multizone systems, single zone unit discharge temperatures.
 - 2. Adjust discharge temperatures to most energy efficient levels satisfying measured load by:
 - a. Raising cooling temperatures to highest possible value.

- b. Reducing heating temperatures to lowest possible level.
 - 3. Operator Commands:
 - a. Add/delete fan status point.
 - b. Lock/unlock program.
 - c. Request HVAC point summary.
 - d. Add/Delete discharge controller point.
 - e. Define discharge controller parameters.
 - f. Add/delete air flow rate.
 - g. Define space load and load parameters.
 - 4. Control Summary:
 - a. HVAC control system status (begin/end).
 - b. Supply air reset system status.
 - c. Optimal run time system status.
 - d. Heating and cooling loop.
 - e. High/low limits.
 - f. Deadband.
 - g. Response timer.
 - h. Reset times.
- C. Enthalpy Switchover:
 - 1. Calculate outside and return air enthalpy using measured temperature and relative humidity; determine energy expended and control outside and return air dampers.
 - 2. Operator Commands:
 - a. Add/delete fan status point.
 - b. Add/delete outside air temperature point.
 - c. Add/delete discharge controller point.
 - d. Define discharge controller parameters.
 - e. Add/delete return air temperature point.
 - f. Add/delete outside air dew point/humidity point.
 - g. Add/delete return air dew point/humidity point.
 - h. Add/delete damper switch.
 - i. Add/delete minimum outside air.
 - j. Add/delete heating override switch.
 - k. Add/delete air flow rate.
 - l. Define enthalpy deadband.
 - m. Lock/unlock program.
 - 3. Control Summary:
 - a. HVAC control system begin/end status.
 - b. Enthalpy switchover optimal system status.
 - c. Current outside air enthalpy.

PART 3 EXECUTION

3.1 INSTALLERS

- A. Installer List:
 - 1. TRI-M GROUP.
 - 2. NRG CONTROLS.
 - 3. CM3 BUILDING SOLUTIONS.

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3.2 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that conditioned power supply is available to the control units and to the operator work station. Verify that field end devices, wiring, and pneumatic tubing is installed prior to installation proceeding.

3.3 INSTALLATION

- A. Install control units and other hardware in position on permanent walls where not subject to excessive vibration.
- B. Install software in control units and in operator work station. Implement all features of programs to specified requirements and appropriate to sequence of operation.
- C. Provide with 120v AC, 15 amp dedicated emergency power circuit to each programmable control unit.
- D. Provide conduit and electrical wiring in accordance with Section 26 05 83. Electrical material and installation shall be in accordance with appropriate requirements of .

3.4 MANUFACTURER'S FIELD SERVICES

- A. Start and commission systems. Allow sufficient time for start-up and commissioning prior to placing control systems in permanent operation.
- B. Provide service engineer to instruct Owner's representative in operation of systems plant and equipment for 3 day period.
- C. Provide basic operator training for 3 persons on data display, alarm and status descriptors, requesting data, execution of commands and request of logs. Include a minimum of 40 hours dedicated instructor time. Provide training on site.

3.5 DEMONSTRATION AND INSTRUCTIONS

- A. Demonstrate complete and operating system to Owner.

3.6 MAINTENANCE

- A. See Section 01 70 00 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.
- B. Provide service and maintenance of energy management and control systems for two years from Date of Substantial Completion.
- C. Provide two complete inspections, one in each season, to inspect, calibrate, and adjust controls as required, and submit written reports.
- D. Provide complete service of systems, including call backs. Make minimum of 4 complete normal inspections of approximately 8 hours duration in addition to normal service calls to inspect, calibrate, and adjust controls, and submit written reports.

3.7 START-UP

- A. provide all start-up and commissioning procedures for a complete installation.

END OF SECTION 23 09 23

SECTION 23 11 23**FACILITY NATURAL-GAS PIPING****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Pipe, pipe fittings, and connections for natural gas piping systems.

1.2 RELATED REQUIREMENTS

- A. Division 01 - General Requirements

1.3 REFERENCE STANDARDS

- A. ANSI Z21.18/CSA 6.3 - Gas Appliance Pressure Regulators; 2007 (Reaffirmed 2012).
- B. ANSI Z223.1 - National Fuel Gas Code; 2015.
- C. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Welding, Brazing, and Fusing Qualifications; 2015.
- D. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2011.
- E. ASME B31.9 - Building Services Piping; 2014.
- F. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2012.
- G. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2015.
- H. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2015.
- I. ASTM D2513 - Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings; 2014.
- J. ASTM D2683 - Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing; 2014.
- K. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2009.
- L. MSS SP-78 - Cast Iron Plug Valves, Flanged and Threaded Ends; 2011.
- M. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010.

1.4 SUBMITTALS

- A. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.
- B. Welders' Certificates: Submit certification of welders' compliance with ASME BPVC-IX.
- C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.

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1.5 QUALITY ASSURANCE

- A. Perform work in accordance with applicable codes.
- B. Welding Materials and Procedures: Comply with ASME BPVC-IX and applicable state labor regulations.
- C. Welder Qualifications: Certified in accordance with ASME BPVC-IX.
- D. Identify pipe with marking including size, ASTM material classification, and ASTM specification.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.7 FIELD CONDITIONS

- A. Do not install underground piping when bedding is wet or frozen.

PART 2 PRODUCTS**2.1 NATURAL GAS PIPING, BURIED BEYOND 5 FEET OF BUILDING**

- A. Polyethylene Pipe: ASTM D2513, SDR 11.
 - 1. Fittings: ASTM D2683 or ASTM D2513 socket type.
 - 2. Joints: Fusion welded.

2.2 NATURAL GAS PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. Steel Pipe: ASTM A53/A53M, Schedule 40 black.
 - 1. Fittings: ASTM A234/A234M, wrought steel welding type.
 - 2. Joints: ANSI Z223.1, welded.
 - 3. Jacket: AWWA C105/A21.5 polyethylene jacket or double layer, half-lapped 10 mil polyethylene tape.

2.3 NATURAL GAS PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53/A53M, Schedule 40 black.
 - 1. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M, wrought steel welding type.
 - 2. Joints: Threaded or welded to ASME B31.1.

2.4 FLANGES, UNIONS, AND COUPLINGS

- A. Unions for Pipe Sizes 3 Inches and Under:
 - 1. Ferrous Pipe: Class 150 malleable iron threaded unions.
- B. Flanges for Pipe Size Over 1 Inch:
 - 1. Ferrous Pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.

2.5 PIPE HANGERS AND SUPPORTS

- A. Provide hangers and supports that comply with MSS SP-58.

1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
2. Overhead Supports: Individual steel rod hangers attached to structure or to trapeze hangers.
3. Trapeze Hangers: Welded steel channel frames attached to structure.
4. Vertical Pipe Support: Steel riser clamp.

2.6 BALL VALVES

- A. Manufacturers:
1. Apollo Valves: www.apollovalves.com/#sle.
 2. Grinnell Products: www.grinnell.com/#sle.
 3. Milwaukee Valve Company: www.milwaukeevalve.com/#sle.

2.7 PLUG VALVES

- A. Construction 2-1/2 Inches and Larger: MSS SP-78, 175 psi CWP, cast iron body and plug, pressure lubricated, Teflon or Buna N packing, flanged or grooved ends. Provide lever operator with set screw.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- C. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- D. Install piping to maintain headroom, conserve space, and not interfere with use of space.
- E. Group piping whenever practical at common elevations.
- F. Provide access where valves and fittings are not exposed.
- G. Establish elevations of buried piping outside the building to ensure not less than 3 ft of cover.
- H. Install vent piping penetrating roofed areas to maintain integrity of roof assembly; refer to Section ____.
- I. Provide support for utility meters in accordance with requirements of utility companies.
- J. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting.
1. Painting of interior piping systems and components is specified in Section 09 91 23.
 2. Painting of exterior piping systems and components is specified in Section 09 91 13.
- K. Excavate in accordance with Section 31 23 16.

- L. Backfill in accordance with Section 31 23 23.
- M. Install valves with stems upright or horizontal, not inverted.
- N. Pipe vents from gas pressure reducing valves to outdoors and terminate in weather proof hood.
- O. Sleeve pipes passing through partitions, walls and floors.
- P. Inserts:
 - 1. Provide inserts for placement in concrete formwork.
 - 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
 - 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 - 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
- Q. Pipe Hangers and Supports:
 - 1. Install in accordance with ASME B31.9.
 - 2. Support horizontal piping as indicated.
 - 3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
 - 4. Place hangers within 12 inches of each horizontal elbow.
 - 5. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 - 6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 - 7. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
 - a. Painting of interior piping systems and components is specified in Section 09 91 23.
 - b. Painting of exterior piping systems and components is specified in Section 09 91 13.
 - 8. Provide hangers adjacent to motor driven equipment with vibration isolation; refer to Section 22 05 48.

3.4 APPLICATION

- A. Install unions downstream of valves and at equipment or apparatus connections.
- B. Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- C. Provide plug valves in natural gas systems for shut-off service.

3.5 SCHEDULES

- A. Pipe Hanger Spacing:
 - 1. Metal Piping:
 - a. Pipe Size: 1/2 inches to 1-1/4 inches:
 - 1) Maximum Hanger Spacing: 6.5 ft.
 - 2) Hanger Rod Diameter: 3/8 inches.
 - b. Pipe Size: 1-1/2 inches to 2 inches:
 - 1) Maximum Hanger Spacing: 10 ft.
 - 2) Hanger Rod Diameter: 3/8 inch.
 - c. Pipe Size: 2-1/2 inches to 3 inches:
 - 1) Maximum Hanger Spacing: 10 ft.

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- 2) Hanger Rod Diameter: 1/2 inch.
- d. Pipe Size: 4 inches to 6 inches:
 - 1) Maximum Hanger Spacing: 10 ft.
 - 2) Hanger Rod Diameter: 5/8 inch.

END OF SECTION 23 11 23

SECTION 23 21 13**HYDRONIC PIPING****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Hydronic system requirements.
- B. Heating water piping, above grade.
- C. Chilled water piping, above grade.
- D. Equipment drains and overflows.
- E. Pipe hangers and supports.
- F. Unions, flanges, mechanical couplings, and dielectric connections.
- G. Valves:
 - 1. Ball valves.
 - 2. Butterfly valves.
 - 3. Check valves.

1.2 RELATED REQUIREMENTS

- A. Division 01 - General Requirements
- B. Section 23 05 53 - Identification for HVAC Piping and Equipment.
- C. Section 23 07 19 - HVAC Piping Insulation.
- D. Section 23 21 14 - Hydronic Specialties.

1.3 REFERENCE STANDARDS

- A. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Welding, Brazing, and Fusing Qualifications; 2015.
- B. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2011.
- C. ASME B16.15 - Cast Copper Alloy Threaded Fittings Classes 125 and 250; 2013.
- D. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2012.
- E. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2013.
- F. ASME B16.34 - Valves - Flanged, Threaded and Welding End; 2013.
- G. ASME B31.9 - Building Services Piping; 2014.
- H. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2012.
- I. ASTM A106/A106M - Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service; 2014.
- J. ASTM A183 - Standard Specification for Carbon Steel Track Bolts and Nuts; 2003 (Reapproved 2009).

- K. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2015.
- L. ASTM A536 - Standard Specification for Ductile Iron Castings; 1984 (Reapproved 2014).
- M. ASTM B32 - Standard Specification for Solder Metal; 2008 (Reapproved 2014).
- N. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2014.
- O. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2013.
- P. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2015.
- Q. ASTM D2000 - Standard Classification System for Rubber Products in Automotive Applications; 2012.
- R. ASTM D2241 - Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series); 2015.
- S. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40; 2013.
- T. ASTM D2467 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80; 2006.
- U. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings; 1996 (Reapproved 2010).
- V. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers; 1992 (Reapproved 2008).
- W. ASTM F876 - Standard Specification for Crosslinked Polyethylene (PEX) Tubing; 2013a.
- X. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications; 2007 (Reapproved 2013).
- Y. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2011-AMD 1.
- Z. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2015.
- AA. AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings; 2012.
- AB. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings; 2012.
- AC. AWWA C606 - Grooved and Shouldered Joints; 2011.
- AD. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2009.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.
- B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.5 SUBMITTALS

- A. Welders Certificate: Include welders certification of compliance with ASME BPVC-IX.
- B. Product Data:
 - 1. Include data on pipe materials, pipe fittings, valves, and accessories.
 - 2. Provide manufacturers catalog information.
 - 3. Indicate valve data and ratings.
 - 4. Show grooved joint couplings, fittings, valves, and specialties on drawings and product submittals, specifically identified with the manufacturer's style or series designation.
- C. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.
- D. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with minimum three years of documented experience.
- B. Provide all grooved joint couplings, fittings, valves, specialties, and grooving tools from a single manufacturer.
- C. Date stamp all castings used for coupling housings, fittings, valve bodies, etc. for quality assurance and traceability.
- D. Coupling Manufacturer:
 - 1. Perform on-site training by factory-trained representative to the Contractor's field personnel in the proper use of grooving tools and installation of grooved joint products.
 - 2. Periodic job site visits by factory-trained representative to ensure best practices in grooved joint installation.
 - 3. A distributor's representative is not considered qualified to perform the training.
- E. Welder Qualifications: Certify in accordance with ASME BPVC-IX.
 - 1. Provide certificate of compliance from authority having jurisdiction, indicating approval of welders.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary protective coating on cast iron and steel valves.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.8 FIELD CONDITIONS

- A. Do not install underground piping when bedding is wet or frozen.

PART 2 PRODUCTS**2.1 HYDRONIC SYSTEM REQUIREMENTS**

- A. Comply with ASME B31.9 and applicable federal, state, and local regulations.

- B. Piping: Provide piping, fittings, hangers, and supports as required, as indicated, and as follows:
1. Where more than one piping system material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.
 2. Use non-conducting dielectric connections whenever jointing dissimilar metals.
 3. Grooved mechanical joints may be used in accessible locations only.
 - a. Accessible locations include those exposed on interior of building, in pipe chases, and in mechanical rooms, aboveground outdoors, and as approved by Engineer.
 - b. Grooved mechanical connections and joints comply with AWWA C606.
 - 1) Ductile Iron: Comply with ASTM A536, Grade 65-45-12.
 - 2) Steel: Comply with ASTM A106/A106M, Grade B or ASTM A53/A53M.
 - c. Use rigid joints unless otherwise indicated.
 - d. Use gaskets of molded synthetic rubber with central cavity, pressure-responsive configuration, and complying with ASTM D2000, Grade 2CA615A15B44F17Z for circulating medium up to maximum 230 degrees F or Grade M3BA610A15B44Z for circulating medium up to maximum 200 degrees F.
 - e. Provide steel coupling nuts and bolts complying with ASTM A183.
 4. Provide pipe hangers and supports in accordance with ASME B31.9 or MSS SP-58 unless indicated otherwise.
- C. Pipe-to-Valve and Pipe-to-Equipment Connections: Use flanges, unions, or grooved couplings to allow disconnection of components for servicing; do not use direct welded, soldered, or threaded connections.
1. Where grooved joints are used in piping, provide grooved valve/equipment connections if available; if not available, provide flanged ends and grooved flange adapters.
- D. Valves: Provide valves where indicated:
1. Provide drain valves where indicated, and if not indicated, provide at least at main shut-off, low points of piping, bases of vertical risers, and at equipment. Use 3/4 inch gate valves with cap; pipe to nearest floor drain.
 2. Isolate equipment using butterfly valves with lug end flanges or grooved mechanical couplings.
 3. For throttling, bypass, or manual flow control services, use globe, ball, or butterfly valves.
 4. For shut-off and to isolate parts of systems or vertical risers, use gate, ball, or butterfly valves.
 5. For throttling service, use plug cocks. Use non-lubricated plug cocks only when shut-off or isolating valves are also provided.
- E. Welding Materials and Procedures: Comply with ASME BPVC-IX.

2.2 HEATING HOT WATER, CHILLED WATER AND GLYCOL PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53/A53M, Schedule 40, black, using one of the following joint types:
1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D1.1/D1.1M welded.
 2. Threaded Joints: ASME B16.3, malleable iron fittings.
 3. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.
- B. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), drawn, using one of the following joint types:
1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings.
 - a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
 - b. Braze: AWS A5.8M/A5.8 BCuP copper/silver alloy.
 2. Grooved Joints: AWWA C606 grooved tube, fittings of same material, and copper-tube-dimension mechanical couplings.
 3. Tee Connections: Mechanically extracted collars with notched and dimpled branch tube.

4. Mechanical Press Sealed Fittings: Double pressed type complying with ASME B16.22, utilizing EPDM, nontoxic synthetic rubber sealing elements.
 - a. Manufacturers:
 - 1) Viega LLC: www.viega.us/#sle.
 - 2) Substitutions: See Section 01 60 00 - Product Requirements.

2.3 EQUIPMENT DRAINS AND OVERFLOWS

- A. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), drawn; using one of the following joint types:
 1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings; ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
- B. PVC Pipe: ASTM D1785, Schedule 40, or ASTM D2241, SDR 21 or 26.
 1. Fittings: ASTM D2466 or D2467, PVC.
 2. Joints: Solvent welded in accordance with ASTM D2855.

2.4 PIPE HANGERS AND SUPPORTS

- A. Provide hangers and supports that comply with MSS SP-58.
 1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
 2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
 3. Hangers for Cold Pipe Sizes 2 Inches and Greater: Carbon steel, adjustable, clevis.
 4. Hangers for Hot Pipe Sizes 2 to 4 Inches: Carbon steel, adjustable, clevis.
 5. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 6. Vertical Support: Steel riser clamp.
 7. Floor Support for Hot Pipe Sizes to 4 Inches: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 8. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
 9. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
 10. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.
- B. In grooved installations, use rigid couplings with offsetting angle-pattern bolt pads or with wedge-shaped grooves in header piping to permit support and hanging in accordance with ASME B31.9.

2.5 UNIONS, FLANGES, MECHANICAL COUPLINGS, AND DIELECTRIC CONNECTIONS

- A. Unions for Pipe 2 Inches and Less:
 1. Ferrous Piping: 150 psig malleable iron, threaded.
 2. Copper Pipe: Bronze, soldered joints.
- B. Flanges for Pipe 2 Inches and Greater:
 1. Ferrous Piping: 150 psig forged steel, slip-on.
 2. Copper Piping: Bronze.
 3. Gaskets: 1/16 inch thick, preformed neoprene.
- C. Mechanical Couplings for Grooved and Shouldered Joints: Two or more curved housing segments with continuous key to engage pipe groove, circular C-profile gasket, and bolts to secure and compress gasket.
 1. Dimensions and Testing: In accordance with AWWA C606.
 2. Mechanical Couplings: Comply with ASTM F1476.
 3. Housing Material: Ductile iron, galvanized complying with ASTM A536.

4. Gasket Material: EPDM suitable for operating temperature range from minus 30 degrees F to 230 degrees F.
 5. Bolts and Nuts: Hot dipped galvanized or zinc-electroplated steel.
 6. When pipe is field grooved, provide coupling manufacturer's grooving tools.
 7. Manufacturers:
 - a. Victaulic Company: www.victaulic.com/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- D. Dielectric Connections:
1. Waterways:
 - a. Water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint.
 - b. Dry insulation barrier able to withstand 600-volt breakdown test.
 - c. Construct of galvanized steel with threaded end connections to match connecting piping.
 - d. Suitable for the required operating pressures and temperatures.
 2. Flanges:
 - a. Dielectric flanges with same pressure ratings as standard flanges.
 - b. Water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint.
 - c. Dry insulation barrier able to withstand 600-volt breakdown test.
 - d. Construct of galvanized steel with threaded end connections to match connecting piping.
 - e. Suitable for the required operating pressures and temperatures.

2.6 BALL VALVES

- A. Manufacturers:
1. Apollo Valves: www.apollovalves.com/#sle.
 2. Grinnell Products: www.grinnell.com/#sle.
 3. Victaulic Company: www.victaulic.com/#sle.
 4. Viega LLC: www.viega.us/#sle.
 5. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Up To and Including 2 Inches:
1. Bronze one piece body, chrome plated brass ball, teflon seats and stuffing box ring, lever handle with balancing stops, solder ends with union.
- C. Over 2 Inches:
1. Ductile iron body, chrome plated stainless steel ball, teflon or Virgin TFE seat and stuffing box seals, lever handle, flanged ends, rated to 800 psi.

2.7 BUTTERFLY VALVES

- A. Manufacturers:
1. Apollo Valves: www.apollovalves.com/#sle.
 2. Grinnell Products: www.grinnell.com/#sle.
 3. Victaulic Company: www.victaulic.com/#sle.
 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Body: Cast or ductile iron with resilient replaceable EPDM seat, wafer, lug, or grooved ends, extended neck.
- C. Disc: Construct of aluminum bronze, chrome plated ductile iron, stainless steel, ductile iron with EPDM encapsulation, or Buna-N encapsulation.

- D. Operator: 10 position lever handle.

2.8 SPRING LOADED CHECK VALVES

- A. Manufacturers:
1. Victaulic Company: www.victaulic.com/#sle.
 2. Metra-flex.
- B. Iron body, bronze trim, split plate, hinged with stainless steel spring, resilient seal bonded to body, wafer, or threaded lug ends.

PART 3 EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Prepare pipe for grooved mechanical joints as required by coupling manufacturer.
- C. Remove scale and dirt on inside and outside before assembly.
- D. Prepare piping connections to equipment using jointing system specified.
- E. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.
- F. After completion, fill, clean and flush system with clean water. Remove and clean or replace all strainer screens. After cleaning and flushing, but before balancing, remove strainers in pump suction diffusers.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.
- C. Route piping in orderly manner, parallel to building structure, and maintain gradient.
- D. Install piping to conserve building space and to avoid interference with use of space.
- E. Group piping whenever practical at common elevations.
- F. Sleeve pipe passing through partitions, walls, and floors.
- G. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified 078413.
- H. Slope piping and arrange to drain at low points.
- I. Grooved Joints:
1. Install in accordance with the manufacturer's latest published installation instructions.
 2. Gaskets to be suitable for the intended service, molded, and produced by the coupling manufacturer.
- J. Inserts:
1. Provide inserts for placement in concrete formwork.
 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.

4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
- K. Pipe Hangers and Supports:
1. Install in accordance with ASME B31.9, ASTM F708, or MSS SP-58.
 2. Install hangers to provide minimum 1/2-inch space between finished covering and adjacent work.
 3. Place hangers within 12 inches of each horizontal elbow.
 4. Use hangers with 1-1/2 inches minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 5. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
 6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 7. Provide copper plated hangers and supports for copper piping.
 8. Prime coat exposed steel hangers and supports. See Section 09 91 23. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- L. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. See Section 23 07 19.
- M. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 08 31 00.
- N. Use eccentric reducers to maintain top of pipe level.
- O. Install valves with stems upright or horizontal, not inverted.

3.3 SCHEDULES

- A. Hanger Spacing for Copper Tubing.
1. 1/2 Inch and 3/4 inch: Maximum span, 5 feet; minimum rod size, 1/4 inch.
 2. 1 Inch: Maximum span, 6 feet; minimum rod size, 1/4 inch.
 3. 1-1/2 Inches and 2 Inches: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 4. 2-1/2 Inches: Maximum span, 9 feet; minimum rod size, 3/8 inch.
 5. 3 Inches: Maximum span, 10 feet; minimum rod size, 3/8 inch.
 6. 4 Inches: Maximum span, 12 feet; minimum rod size, 1/2 inch.
- B. Hanger Spacing for Steel Piping.
1. 1/2 Inch, 3/4 Inch, and 1 Inch: Maximum span, 7 feet; minimum rod size, 1/4 inch.
 2. 1-1/4 Inches: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 3. 1-1/2 Inches: Maximum span, 9 feet; minimum rod size, 3/8 inch.
 4. 2 Inches: Maximum span, 10 feet; minimum rod size, 3/8 inch.
 5. 2-1/2 Inches: Maximum span, 11 feet; minimum rod size, 3/8 inch.
 6. 3 Inches: Maximum span, 12 feet; minimum rod size, 3/8 inch.
 7. 4 Inches: Maximum span, 14 feet; minimum rod size, 1/2 inch.

END OF SECTION 23 21 13

SECTION 23 21 14
HYDRONIC SPECIALTIES**PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Expansion tanks.
- B. Air vents.
- C. Air separators.
- D. Strainers.
- E. Suction diffusers.
- F. Pump connectors.
- G. Pressure-temperature test plugs.
- H. Balancing valves.
- I. Coil hook-up kits.
- J. Combination flow controls.
- K. Relief valves.
- L. Pressure reducing valves.
- M. Glycol system.

1.2 RELATED REQUIREMENTS

- A. Section 01 - General Requirements
- B. Section 23 09 23 - Direct-Digital Control System for HVAC
- C. Section 23 21 13 - Hydronic Piping.
- D. Section 26 27 17 - Equipment Wiring

1.3 REFERENCE STANDARDS

- A. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2010.
- B. ASME B16.5 - Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard; 2013.
- C. ASME B16.11 - Forged Fittings, Socket-welding and Threaded; 2011.
- D. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1 - Rules for Construction of Pressure Vessels; 2015.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

- B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.5 **SUBMITTALS**

- A. Listed manufacturers and series are for reference only and do not promote any single product. Series are provided for reference, and should not be used as an ordering model number. Accessories and options may be custom components purchased separately.
- B. Product Data: Provide manufacturer's catalog sheet for equipment indicating rough-in size, finish, and accessories. Manufacturer's data sheets on each item of equipment and device, marked up to identify the items to be used on the project.
- | | |
|-------------------------------------|----------------------|
| 1. Expansion tanks. | (23 21 14 - 001 - A) |
| 2. Air vents. | (23 21 14 - 002 - A) |
| 3. Air separators. | (23 21 14 - 002 - A) |
| 4. Strainers. | (23 21 14 - 002 - A) |
| 5. Suction diffusers. | (23 21 14 - 003 - A) |
| 6. Pressure-temperature test plugs. | (23 21 14 - 004 - A) |
| 7. Balancing valves. | (23 21 14 - 004 - A) |
| 8. Coil hook-up kits. | (23 21 14 - 004 - A) |
| 9. Combination flow controls. | (23 21 14 - 004 - A) |
| 10. Relief valves. | (23 21 14 - 004 - A) |
| 11. Pressure reducing valves. | (23 21 14 - 004 - A) |
| 12. Glycol system. | (23 21 17 - 006 - A) |
- C. Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description and model.
- D. Certificates: Inspection certificates for pressure vessels from authority having jurisdiction.
- E. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.
- F. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.
- | |
|--|
| 1. Submit under Operation and Maintenance Data books |
| 2. Expansion Tanks. |
| 3. Strainers. |
| 4. Balancing valves. |
| 5. Coil hook-up kits. |
| 6. Combinations flow controls. |
| 7. Pressure reducing valves. |
| 8. Glycol system. |
- G. Project Record Documents: Record actual locations of components and locations of access doors required for access or valving.
- | |
|---|
| 1. Refer to Section 01 78 00 - Closeout Submittals. |
| 2. Record Documents. |
- H. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listings.
- | |
|---|
| 1. Refer to Section 01 78 00 - Closeout Submittals. |
| 2. Operation and Maintenance Data Books. |
| 3. Operation and Maintenance DVD. |

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- I. Project Record Documents:
- J. Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.6 WARRANTY

- A. Provide 3 year warranty, including parts, materials and labor for defective parts, for the following:
 - 1. Include in Closeout Submittals Book.
 - 2. Expansion Tanks.
 - 3. Strainers.
 - 4. Balancing valves.
 - 5. Coil hook-up kits.
 - 6. Combinations flow controls.
 - 7. Pressure reducing valves.
 - 8. Glycol system.

1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary protective coating on cast iron and steel valves.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS**2.1 EXPANSION TANKS**

- A. Manufacturers:
 - 1. Amtrol, Inc.
 - 2. ITT Bell & Gossett.
 - 3. Taco, Inc.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Construction: Welded steel, tested and stamped in accordance with ASME (BPV VIII, 1); supplied with National Board Form U-1, rated for working pressure of 150 psi, with flexible butyl diaphragm or bladder sealed into tank, and steel support stand.
- C. Accessories: Pressure gauge and air-charging fitting, tank drain; precharge to 12 psi.
- D. Automatic Cold Water Fill Assembly: Pressure reducing valve, reduced pressure zone back flow preventer, test cocks, strainer, vacuum breaker, and valved by-pass.

2.2 AIR VENTS

- A. Manufacturers:
 - 1. Armstrong International, Inc.

2. ITT Bell & Gossett.
 3. Taco, Inc.
 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Manual Type: Short vertical sections of 2-inch diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.
- C. Float Type:
1. Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.
 2. Cast iron body and cover, float, bronze pilot valve mechanism suitable for system operating temperature and pressure; with isolating valve.

2.3 AIR SEPARATORS

- A. In-line Air Separators:
1. Manufacturers:
 - a. ITT Bell & Gossett.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
 2. Cast iron for sizes 1-1/2 inch and smaller, or steel for sizes 2 inch and larger; tested and stamped in accordance with ASME BPVC-VIII-1; for 125 psi operating pressure.
 3. Maximum Allowable Service Temperature: 450 degrees F.
 4. One-piece cast iron with an integral weir constructed to decelerate system flow to maximize air separation.
 5. Maximum Working Pressure: Up to 175 psig.
 6. Maximum Operating Temperature: Up to 300 deg F.
- B. Centrifugal Air Separators/Strainers:
1. Manufacturers:
 - a. Armstrong International, Inc.
 - b. ITT Bell & Gossett.
 - c. Taco, Inc.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
 2. Steel, tested and stamped in accordance with ASME BPVC-VIII-1; for 125 psi operating pressure, with integral bronze strainer, tangential inlet and outlet connections, and internal stainless steel air collector tube.
 3. Maximum Service Flow and Pressure: 16 gpm at 125 psi.

2.4 STRAINERS

- A. Manufacturers:
1. Armstrong International, Inc.
 2. Flexicraft Industries.
 3. Grinnell Products, a Tyco Business.
 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Size 2 inch and Under:
1. Screwed brass or iron body for 175 psi working pressure, Y pattern with 1/32 inch stainless steel perforated screen.
- C. Size 2-1/2 inch to 4 inch:
1. Provide flanged or grooved iron body for 175 psi working pressure, Y pattern with 1/16 inch, or 3/64 inch stainless steel perforated screen.

2.5 SUCTION DIFFUSERS

- A. Manufacturers:
 - 1. ITT Bell & Gossett.
 - 2. Victaulic Company of America.
 - 3. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Fitting: Angle pattern, cast-iron body, threaded for 2 inch and smaller, flanged for 2-1/2 inch and larger, rated for 175 psi working pressure, with inlet vanes, cylinder strainer with 3/16 inch diameter openings, disposable 5/32 inch mesh strainer to fit over cylinder strainer, 20 mesh startup screen, and permanent magnet located in flow stream and removable for cleaning.
- C. Accessories: Adjustable foot support, blowdown tapping in bottom, gauge tapping in side.

2.6 PUMP CONNECTORS

- A. Manufacturers:
 - 1. The Metraflex Company; Vane Flex.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Flexible Connectors: Flanged, braided type with wetted components of stainless steel, sized to match piping.
 - 1. Maximum Allowable Working Pressure: 150 psig at 120 degrees F.
 - 2. End Connections: Flanged ductile iron; complying with ASME B16.1 Class 125.
 - 3. Provide necessary accessories including, but not limited to, swivel joints.

2.7 PRESSURE-TEMPERATURE TEST PLUGS

- A. Manufacturers:
 - 1. Peterson Equipment Company Inc.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Construction: Brass body designed to receive temperature or pressure probe with removable protective cap, and Neoprene rated for minimum 200 degrees F.
- C. Application: Use extended length plugs to clear insulated piping.

2.8 BALANCING VALVES

- A. Manufacturers:
 - 1. Armstrong International, Inc.
 - 2. ITT Bell & Gossett.
 - 3. Taco, Inc.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Size 2 inch and Smaller:
- C. Provide ball style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and NPT threaded or soldered connections.
- D. Metal construction materials consist of bronze or brass.
- E. Non-metal construction materials consist of Teflon, EPDM, or engineered resin.
- F. Size 2.5 inch and Larger:

1. Provide ball, globe, or butterfly style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and flanged, grooved, or weld end connections.
2. Valve body construction materials consist of cast iron, carbon steel, or ductile iron.
3. Internal components construction materials consist of brass, aluminum bronze, bronze, Teflon, or EPDM.

2.9 COIL HOOK-UP KITS

- A. Manufacturers:
 1. Nexus Valve: Coil Pak 03Y.
 2. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Under Contractor's option, coil hook-up kits may be used in lieu of individual specified components with the detail for connecting a 2-way or 3-way hydronic valve. The coil connection kit must provide all of the same functions as the individual components. The fittings shall remain line size similar to how individual components would be sizes and the final reduction in size for the coil is at the coil connection.
- C. Combination valve with manual flow control valve, with setting indicator, PT test plugs, memory stop and union ends. Valve shall also operate as isolation valve.
 1. 600 PSI WOG, 325 Degree F rated.
 2. Valve: Stainless Steel ball, full port.
 3. Manufacture: Nexus Valve: Series Ultra XB Orturi.
- D. Combination casting with Union, Manual Air vent and PT Test Plug:
 1. Manufacture: Nexus Valve UltraU.
- E. In the bypass leg for 3-way valves, combination valve with Ball valve, memory stop and union end.
 1. Manufacturer: Nexus Valve Ultra NXU.
- F. In supply piping, Combination valve with Ball valve, strainer, union end, PT test plug blowdown valve with cap.
 1. 304 stainless steel 40 mesh screen.
 2. Valve: Stainless Steel ball, full port.
 3. Manufacturer: Nexus Valve Ultra Y.
- G. Flexible EPDM core, Stainless braided hose for connection to coil.
 1. Rated for 300 psi or greater at 180 degrees F.

2.10 RELIEF VALVES

- A. Manufacturers:
 1. Armstrong International, Inc.
 2. ITT Bell & Gossett.
 3. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labelled.

2.11 PRESSURE REDUCING VALVES

- A. Manufacturers:
 1. Armstrong International, Inc.
 2. ITT Bell & Gossett.

- 3. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Operation: Automatically feeds make-up water to the hydronic system whenever pressure in the system drops below the pressure setting of the valve.
- C. Materials of Construction:
 - 1. Valve Body: Constructed of bronze or brass.
 - 2. Internal Components: Construct of brass and engineered plastics or composition material.
- D. Connections:
 - 1. NPT threaded: 0.75 inch.
 - 2. Soldered: 0.75 inch.
- E. Provide integral check valve and strainer.
- F. Maximum Inlet Pressure: 100 psi.
- G. Maximum Fluid Temperature: 180 degrees F.
- H. Operating Pressure Range: Between 10 psi and 25 psi.

2.12 GLYCOL SYSTEM

- A. Mixing Tank: 55 gallon steel drum with fittings suitable for filling and hand pump for charging, rubber hose for connection of hand pump to system.
- B. Storage Tank: Closed type, welded-steel construction, tested and stamped in accordance with ASME BPVC-VIII-1; 100 psi rating; cleaned, prime coated, and supplied with steel support saddles. Construct with tapings for installation of accessories.
- C. Glycol Solution:
 - 1. Inhibited ethylene glycol and water solution mixed 35 percent glycol - 65 percent water, suitable for operating temperatures from -20 degrees F to 250 degrees F.

PART 3 EXECUTION

3.1 INTERFACE WITH WORK OF OTHER SECTIONS

- A. Confirm framing and support members.
- B. Confirm rough-in and framing of walls and partitions with supports for equipment and accessories.
- C. Confirm rough-in locations and control system requirements before rough-in installation. Refer to Section 23 09 23 - Direct-Digital Control System for HVAC.
- D. Confirm rough-in locations and power requirements before rough-in installation. Refer to Section 26 27 17 - Equipment Wiring.

3.2 EXAMINATION

- A. Verify that surfaces are suitable for installation.
- B. Examine areas to receive equipment for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- C. Verify that piping and equipment are ready to receive work.
- D. Verify field measurements are as shown on shop drawings.

- E. Electrical:
 - 1. Verify electrical power, voltage, phase and current is available and of the correct characteristics.
 - 2. Verify rough-in for electrical connections to verify actual locations before installing.
 - 3. Verify motor type and VFD or disconnect type for compatibility prior to ordering equipment.
- F. Controls:
 - 1. Verify signal power, voltage, phase and current is available and of the correct characteristics.
 - 2. Verify rough-in for control connections to verify actual locations before installing.
 - 3. Verify motor type and VFD or disconnect type for compatibility with control sequence and control devices prior to ordering equipment.
- G. Maintain service clearances.
- H. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

- A. Install specialties in accordance with manufacturer's instructions.
- B. Install specialties in accordance with the following:
 - 1. Federal, State and Local codes.
 - 2. Manufacturer's instructions.
 - 3. Contract documents.
- C. Expansion Tanks:
 - 1. Vent and purge air from hydronic system, and ensure that tank is properly charged with air to suit system Project requirements.
 - 2. Provide valved drain and hose connection on expansion tank.
- D. Air Vents:
 - 1. Where large air quantities can accumulate, provide enlarged air collection standpipes.
 - 2. Provide manual air vents at system high points and as indicated.
 - 3. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.
 - 4. Install automatic air vents within mechanical room and service areas only.
- E. Air Separators:
 - 1. Provide air separator on suction side of system circulation pump and connection to expansion tank.
 - 2. Provide full port valved drain and extend to floor drain.
- F. Strainers:
 - 1. Provide valved drain and hose connection on strainer blowdown connection.
- G. Suction Diffusers:
 - 1. Provide pump suction fitting on suction side of base-mounted centrifugal pumps where indicated. Remove temporary strainers after cleaning systems.
- H. Support pump fittings with floor-mounted pipe and flange supports.
- I. Pipe relief valve outlet to nearest floor drain.
- J. Fill system with fresh water and add liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products from piping. Circulate solution for a minimum of 24 hours, drain, clean strainer screens, and refill with fresh water.

- K. Pressure Temperature Test Plugs:
 - 1. Provide test plugs on water inlet and outlet from units and each coil.
- L. Balancing Valves:
 - 1. Install on the outlet of each unit and coil.
 - 2. Install shut off valve upstream and downstream of balancing valve.
 - 3. Install pressure gauge ports upstream and downstream of balancing valve.
- M. Coil Hook-up Kits:
 - 1. Install kits within accessible areas. Maintain clearances for maintenance of valves.
 - 2. Install in locations as indicated for individual assemblies.
- N. Relief Valves:
 - 1. Where one line vents several relief valves, make cross-sectional area equal to sum of individual vent areas.
 - 2. Provide relief valves on pressure tanks, low pressure side of reducing valves, heat exchangers, and expansion tanks.
 - 3. Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.
 - 4. Pipe relief valve outlet to nearest floor drain.
 - 5. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.
- O. Pressure Reducing Valves:
 - 1. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.
 - 2. Install isolation valves and pressure gauges upstream and downstream of valve.
- P. Glycol System:
 - 1. Feed glycol solution to system through make-up line with pressure regulator, venting system high points.
 - 2. Feed glycol solution to system through make-up line with pressure regulator, venting system high points. Set to fill at 12 psi.
 - 3. Feed glycol solution to system through make-up line with pressure regulator, venting system high points. Pressure system cold at 5 psi.
 - 4. Perform tests determining strength of glycol and water solution and submit written test results.

3.4 MAINTENANCE

- A. See Section 01 70 00 - Execution Requirements, for additional requirements relating to maintenance service.
- B. Provide service and maintenance of glycol system for one year from date of Substantial Completion at no extra charge to Owner.
- C. Perform monthly visit for the first four months and then bi-monthly visits for the first year to make water analysis on site with measurement instruments. Report findings in detail in writing, including analysis and amounts of chemicals or water added. Submit report to owner.
- D. Explain corrective actions to Owner's maintenance personnel in person.
- E. Contractor shall provide chemicals required for correcting system.

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3.5 START-UP

- A. Perform start-up for all equipment.
 - 1. Expansion tanks.
 - 2. Air vents.
 - 3. Air separators.
 - 4. Strainers.
 - 5. Suction diffusers.
 - 6. Pressure-temperature test plugs.
 - 7. Balancing valves.
 - 8. Coil hook-up kits.
 - 9. Combination flow controls.
 - 10. Relief valves.
 - 11. Pressure reducing valves.
 - 12. Glycol system.

END OF SECTION 23 21 14

SECTION 23 21 23**HYDRONIC PUMPS****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. In-line circulators.
- B. Base-mounted pumps.

1.2 RELATED REQUIREMENTS

- A. Division 01 - General Requirements
- B. Section 23 09 23 - Direct-Digital Control System for HVAC.
- C. Section 23 21 13 - Hydronic Piping.
- D. Section 23 21 14 - Hydronic Specialties.
- E. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- F. Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- B. UL 778 - Standard for Motor-Operated Water Pumps; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. Listed manufacturers and series are for reference only and do not promote any single product. Series are provided for reference, and should not be used as an ordering model number. Accessories and options may be custom components purchased separately.
- B. Product Data: Provide certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.
 - 1. Include rated capacities, operating characteristics, furnished specialties, and accessories.
 - 2. Include mounting brackets, control panels, thermostat and options.
 - 3. Include wiring diagrams: Power, signal and control wiring.
 - 4. In-line circulators. (23 21 23 - 001 - A)
 - 5. Base mounted pumps. (23 21 23 - 001 - A)
- C. Manufacturer's Installation Instructions: Indicate hanging and support requirements and recommendations.
- D. Start-up Report: Indicate start-up results.
 - 1. In-line circulators. (23 21 23 - 002 - A)
 - 2. Base mounted pumps. (23 21 23 - 002 - A)
- E. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.
 - 1. Submit under Operation and Maintenance Data books

- 2. In-line circulators.
- 3. Base mounted pumps.
- F. Project Record Documents: Record actual locations of components and locations of access doors in radiation cabinets required for access or valving.
 - 1. Refer to Section 01 78 00 - Closeout Submittals.
 - 2. Record Documents.
- G. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listings.
 - 1. Refer to Section 01 78 00 - Closeout Submittals.
 - 2. Operation and Maintenance Data Books.
 - 3. Operation and Maintenance DVD.
- H. Operation and Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.5 WARRANTY

- A. Provide 3 year warranty, including parts, materials and labor for defective parts, for the following:
 - 1. Include in Closeout Submittals Book.
 - 2. In-line circulators.
 - 3. Base mounted pumps.

PART 2 PRODUCTS**2.1 MANUFACTURERS**

- A. Armstrong Pumps Inc.
- B. Bell & Gossett, a Xylem Inc. brand.
- C. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 HVAC PUMPS - GENERAL

- A. Provide pumps that operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.
- B. Products Requiring Electrical Connection: Listed and classified by UL or testing agency acceptable to Authority Having Jurisdiction as suitable for the purpose specified and indicated.

2.3 IN-LINE CIRCULATORS

- A. Type: Horizontal shaft, single stage, direct connected, with resiliently mounted motor for in-line mounting, oil lubricated, for 125 psi maximum working pressure.
- B. Casing: Cast iron, with flanged pump connections.
- C. Impeller: Non-ferrous keyed to shaft.
- D. Bearings: Oil-lubricated bronze sleeve.
- E. Shaft: Alloy steel with bronze sleeve, integral thrust collar.
- F. Seal: Mechanical seal, 225 degrees F maximum continuous operating temperature.

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- G. Drive: Flexible coupling.
- H. Manufacturers:
 - 1. Bell & Gossett.

2.4 BASE MOUNTED PUMPS

- A. Manufacturers:
 - 1. Armstrong Pumps Inc.
 - 2. ITT Bell & Gossett.
 - 3. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Type: Horizontal shaft, single stage, direct connected, radially or horizontally split casing, for 125 psi maximum working pressure.
- C. Casing: Cast iron, or ductile iron with suction and discharge gauge ports, renewable bronze casing wearing rings, seal flush connection, drain plug, flanged suction and discharge.
- D. Impeller: Bronze, fully enclosed, keyed to shaft.
- E. Bearings: Oil lubricated roller or ball bearings.
- F. Shaft: Alloy steel with copper, bronze, or stainless steel shaft sleeve.
- G. Seal: Mechanical seal, 225 degrees F maximum continuous operating temperature.
- H. Drive: Flexible coupling with coupling guard.
- I. Baseplate: Cast iron or fabricated steel with integral drain rim.
- J. Manufacturers:
 - 1. Armstrong Fluid Technology, Inc; Design Envelope 4200H:
www.armstrongfluidtechnology.com/#sle.
 - 2. Bell & Gossett.
 - 3. Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.1 INTERFACE WITH WORK OF OTHER SECTIONS

- A. Confirm framing and support members.
- B. Confirm rough-in and framing of walls and partitions with supports for equipment and accessories.
- C. Confirm rough-in locations and power requirements before rough-in installation. Refer to Section 23 09 23 - Direct-Digital Control System for HVAC.
- D. Confirm rough-in locations and power requirements before rough-in installation. Refer to Section 26 27 17 - Equipment Wiring.

3.2 EXAMINATION

- A. Verify that surfaces are suitable for installation.
- B. Verify that field measurements are as shown on the drawings.

- C. Examine areas to receive equipment for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- D. Electrical:
 - 1. Verify electrical power, voltage, phase and current is available and of the correct characteristics.
 - 2. Verify rough-in for electrical connections to verify actual locations before installing.
 - 3. Verify motor type and VFD or disconnect type for compatibility prior to ordering equipment.
- E. Controls:
 - 1. Verify signal power, voltage, phase and current is available and of the correct characteristics.
 - 2. Verify rough-in for control connections to verify actual locations before installing.
 - 3. Verify motor type and VFD or disconnect type for compatibility with control sequence and control devices prior to ordering equipment.
- F. Maintain clearances and service clearances.
- G. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 PREPARATION

- A. Provide housekeeping pads for 03 30 00 - Cast-In-Place Concrete.

3.4 PREPARATION

- A. Verify that electric power is available and of the correct characteristics.

3.5 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with the following:
 - 1. Federal, state and local codes.
 - 2. Manufacturer's instructions.
 - 3. NFPA 70 - National Electric Code.
- C. Install equipment level and plumb.
- D. Connect wiring according to Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
- E. Ground equipment according to Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- F. Provide access space around pumps for service. Provide no less than minimum space recommended by manufacturer.
- G. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. For close coupled or base mounted pumps, provide supports under elbows on pump suction and discharge line sizes 4 inches and over.
- H. Provide line sized shut-off valve and strainer on pump suction, and line sized soft seat check valve and balancing valve on pump discharge.
- I. Provide air cock and drain connection on horizontal pump casings.
- J. Provide drains for bases and seals, piped to and discharging into floor drains.
- K. Check, align, and certify alignment of base-mounted pumps prior to start-up.

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- L. Install base-mounted pumps on concrete housekeeping base, with anchor bolts, set and level, and grout in place. Refer to Section 03 30 00.
- M. Lubricate pumps before start-up.
- N. Provide side-stream filtration system for closed loop systems. Install across pump with flow from pump discharge to pump suction from pump tapings.

3.6 START-UP

- A. Perform start-up on all pumps.
 - 1. In-line circulators.
 - 2. Base mounted pumps.

3.7 TRAINING

- A. Perform training on all pumps.
 - 1. In-line circulators.
 - 2. Base mounted pumps.

END OF SECTION 23 21 23

SECTION 23 31 00**HVAC DUCTS AND CASINGS****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Metal Ductwork.
- B. Flexible Duct.
- C. Fume Exhaust Ductwork.

1.2 RELATED REQUIREMENTS

- A. Division 01 - General Requirements
- B. Section 23 07 13 - Duct Insulation: External insulation and duct liner.
- C. Section 23 33 00 - Air Duct Accessories.
- D. Section 23 36 00 - Air Terminal Units.

1.3 REFERENCE STANDARDS

- A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2014.
- B. ASTM A480/A480M - Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip; 2015.
- C. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2015.
- D. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable; 2015.
- E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.
- F. ICC-ES AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements; 2012.
- G. ICC-ES AC106 - Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry Elements; 2012.
- H. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements; 2013.
- I. ICC-ES AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements; 2013.
- J. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2015.
- K. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005.

1.4 SUBMITTALS

- A. Listed manufacturers and series are for reference only and do not promote any single product. Series are provided for reference and should not be used as an ordering model number. Accessories and options may be custom components purchased separately.

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- B. Product Data: Provide manufacturer's most current catalog data sheet for equipment indicating rough-in size, finish and accessories. Manufacturer's data sheets on each item of equipment and device shall be clearly marked up to identify the items, accessories and options to be used on the project.
 - 1. Metal Duct (23 31 00 - 001 - A)
 - 2. Flexible Duct (23 31 00 - 003 - A)
- C. Shop Drawings: Indicate duct fittings, particulars such as gages, sizes, welds, and configuration prior to start of work for ductwork systems.
 - 1. Metal Duct (23 31 00 - 001 - A)
 - 2. Coordination Drawings, provide 1/4" scale ductwork drawings, indicate all ductwork elevations and coordinate with all other trades. (23 31 00 - 002 - A)
- D. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.
 - 1. Refer to Section 01 78 00 - Closeout Submittals.
 - 2. Record Documents.

1.5 SUBMITTALS

- A. Listed manufacturers and series are for reference only and do not promote any single product. Series are provided for reference and should not be used as an ordering model number. Accessories and options may be custom components purchased separately.
- B. Product Data: Provide manufacturer's most current catalog data sheet for equipment indicating rough-in size, finish and accessories. Manufacturer's data sheets on each item of equipment and device shall be clearly marked up to identify the items, accessories and options to be used on the project.
 - 1. Metal Duct (23 31 00 - 001 - A)
 - 2. Flexible Duct (23 31 00 - 003 - A)
- C. Shop Drawings: Indicate duct fittings, particulars such as gages, sizes, welds, and configuration prior to start of work for ductwork systems.
 - 1. Metal Duct (23 31 00 - 001 - A)
 - 2. Coordination Drawings (23 31 00 - 003 - A)
- D. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.
 - 1. Refer to Section 01 78 00 - Closeout Submittals.
 - 2. Record Documents.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience, and approved by manufacturer.

1.7 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Provide 25 year manufacturer's warranty .
 - 1. Include in Closeout Submittals Book.
 - 2. Metal Duct
 - 3. Flexible Duct

1.8 FIELD CONDITIONS

- A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.
- B. Maintain temperatures within acceptable range during and after installation of duct sealants.

PART 2 PRODUCTS**2.1 DUCT ASSEMBLIES**

- A. Regulatory Requirements: Construct ductwork to NFPA 90A standards and schedule on drawings.
- B. Ducts: Galvanized steel, unless otherwise indicated.
- C. Low Pressure Supply (Heating Systems): 2 inch w.g. pressure class, galvanized steel.
- D. Low Pressure Supply (System with Cooling Coils): 2 inch w.g. pressure class, galvanized steel.
- E. Medium and High Pressure Supply: 2" inch w.g. pressure class, galvanized steel.
- F. Fume Hood Exhaust: 1 inch w.g. pressure class, stainless steel.
- G. Outside Air Intake: 1 inch w.g. pressure class, galvanized steel.
- H. Combustion Air: 1 inch w.g. pressure class, galvanized steel.
- I. Transfer Air and Sound Boots: 1 inch w.g. pressure class, galvanized steel.

2.2 MATERIALS

- A. Galvanized Steel for Ducts: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G60/Z180 coating.
- B. Un-Galvanized Steel for Ducts: ASTM A1008/A1008M, Designation CS, cold-rolled commercial steel.
- C. Stainless Steel for Ducts: ASTM A480/A480M, Type 304.
- D. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.
 - 1. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.
 - 2. VOC Content: Not more than 250 g/L, excluding water.
 - 3. Surface Burning Characteristics: Flame spread index of zero and smoke developed index of zero, when tested in accordance with ASTM E84.
 - 4. For Use with Flexible Ducts: UL labeled.
 - 5. Manufacturers:
 - a. Carlisle HVAC Products; Hardcast Iron-Grip 601 Water Based Duct Sealant.
 - b. Design Polymerics; DP 1010 Water Based Smooth Duct Sealant, Zero VOC, Premium Quality: www.designpoly.com/#sle.
 - c. Ductmate Industries, Inc, a DMI Company: www.ductmate.com/#sle.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
- E. Hanger Rod:
 - 1. ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.
 - 2. Humid or harsh environments, stainless steel continuously threaded rod.

- F. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:
1. Concrete Wedge Expansion Anchors: Complying with ICC-ES AC193.
 2. Masonry Wedge Expansion Anchors: Complying with ICC-ES AC01.
 3. Concrete Screw Type Anchors: Complying with ICC-ES AC193.
 4. Masonry Screw Type Anchors: Complying with ICC-ES AC106.
 5. Concrete Adhesive Type Anchors: Complying with ICC-ES AC308.
 6. Other Types: As required.
 7. Manufacturers:
 - a. Powers Fasteners, Inc.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.

2.3 DUCTWORK FABRICATION

- A. Fabricate and support in accordance with SMACNA (DCS) and as indicated.
- B. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
- C. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows must be used, provide air foil turning vanes of perforated metal with glass fiber insulation.
- D. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- E. Fabricate continuously welded round and oval duct fittings in accordance with SMACNA (DCS).
- F. Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide plenum box sealing louver area around duct. Use same material as duct, painted black on exterior side; seal to louver frame and duct.

2.4 MANUFACTURED DUCTWORK AND FITTINGS

- A. Spiral Ducts: Round spiral lockseam duct with galvanized steel outer wall.
 1. Manufacture in accordance with SMACNA (DCS).
- B. Round Ducts: Round lockseam duct with galvanized steel outer wall.
 1. Manufacture in accordance with SMACNA (DCS).
- C. Flexible Ducts: Two ply vinyl film supported by helically wound spring steel wire.
 1. Insulation: Fiberglass insulation with polyethylene vapor barrier film.
 2. Pressure Rating: 10 inches wg positive and 1.0 inches wg negative.
 3. Maximum Velocity: 4000 fpm.
 4. Temperature Range: Minus 10 degrees F to 160 degrees F.
- D. Flexible Ducts: Multiple layers of aluminum laminate supported by helically wound spring steel wire.
 1. UL labeled.
 2. Insulation: Fiberglass insulation with polyethylene vapor barrier film.
 3. Pressure Rating: 10 inches wg positive and 1.0 inches wg negative.
 4. Maximum Velocity: 4000 fpm.
 5. Temperature Range: Minus 20 degrees F to 210 degrees F.
- E. Transverse Duct Connection System: SMACNA "E" rated rigidly class connection, interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips in accordance with SMACNA (DCS).

- F. Round Duct Connection System: Interlocking duct connection system in accordance with SMACNA (DCS).
- G. Fume Hood Exhaust: Minimum 21 gage, 0.0344 inch thick, single wall, Type 304 stainless steel.
 - 1. Single-wall, factory built chimney liner system.
 - 2. Designed, fabricated, and installed liquidtight preventing exhaust leakage into building.
 - 3. Seal joints during installation with factory supplied flanges and airtight gasketing.
 - 4. Manufacturers:
 - a. Selkirk Corporation; Model G.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.1 INTERFACE WITH WORK OF OTHER SECTIONS

- A. Confirm framing and support members.
- B. Confirm rough-in and framing of walls and partitions with supports for equipment and accessories.

3.2 EXAMINATION

- A. Verify that surfaces are suitable for installation.
- B. Examine areas to receive equipment for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- C. Verify that piping and equipment are ready to receive work.
- D. Verify field measurements are as shown on shop drawings.
- E. Maintain clearances to combustibles and service clearances.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

- A. Install, support, and seal ducts in accordance with SMACNA (DCS).
- B. Install in accordance with the following:
 - 1. Federal, State and Local codes.
 - 2. Manufacturer's instructions.
 - 3. SMACNA 1966.
- C. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
- D. Flexible Ducts:
 - 1. Connect inner liner to metal ducts with draw bands.
 - 2. Cover with insulated section.
 - 3. Connect outer cover to metal duct with draw bands and tape.
 - 4. Ducts shall be supported every 2 linear feet.
 - 5. Vertical section of flexible duct down to diffuser shall be aligned for a straight path.
- E. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device

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or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

- F. Use double nuts and lock washers on threaded rod supports.
- G. Connect terminal units to supply ducts directly or with one foot maximum length of flexible duct. Do not use flexible duct to change direction.
- H. Connect diffusers or light troffer boots to low pressure ducts directly or with maximum length of flexible duct held in place with strap or clamp.

3.4 CLEANING

- A. Clean duct system and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment that could be harmed by excessive dirt with temporary filters, or bypass during cleaning.

END OF SECTION 23 31 00

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SECTION 23 33 00**AIR DUCT ACCESSORIES****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Air turning devices/extractors.
- B. Backdraft dampers - metal.
- C. Combination fire and smoke dampers.
- D. Duct access doors.
- E. Duct test holes.
- F. Fire dampers.
- G. Flexible duct connectors.
- H. Volume control dampers.
- I. Low leakage (Class 1A) control dampers.

1.2 RELATED REQUIREMENTS

- A. Section 01 - General Requirements
- B. Section 23 31 00 - HVAC Ducts and Casings.

1.3 REFERENCE STANDARDS

- A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.
- B. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2015.
- C. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations; 2014.
- D. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005.
- E. UL 33 - Safety Heat Responsive Links for Fire-Protection Service; Current Edition, Including All Revisions.
- F. UL 555 - Standard for Fire Dampers; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. Product Data: Provide for shop fabricated assemblies including volume control dampers, duct access doors, and duct test holes. Include electrical characteristics and connection requirements.
 - 1. Fire Dampers (23 33 00 - 001 - A)
 - 2. Volume Control Dampers (23 33 00 - 002 - A)
 - 3. Duct Access Doors (23 33 00 - 003 - A)
 - 4. Storm Louvers (23 33 00 - 004- A)
- B. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.
 - 1. Submit under Operation and Maintenance Data books

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2. Combination Fire and Smoke Dampers
3. Fire Dampers
4. Volume Control Dampers
5. Duct Access Doors

- C. Project Record Drawings: Record actual locations of access doors and test holes.
1. Record Drawings

1.5 **WARRANTY**

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. Provide 3 year warranty, including parts, materials and labor for defective parts, for the following:
1. Include in Closeout Submittals Book.
 2. Combination Fire and Smoke Dampers.
 3. Fire Dampers.
 4. Volume Control Dampers.
 5. Duct Access Doors.

1.6 **DELIVERY, STORAGE, AND HANDLING**

- A. Protect dampers from damage to operating linkages and blades.

PART 2 PRODUCTS

2.1 **AIR TURNING DEVICES/EXTRACTORS**

- A. Manufacturers:
1. Carlisle HVAC Products; Dynair Hollow Vane and Rail (Double Wall Vane).
 2. Elgen Manufacturing, Inc.
 3. Krueger-HVAC, Division of Air System Components.
 4. Ruskin Company, a brand of Johnson Controls.
 5. Titus HVAC, a brand of Johnson Controls.
 6. Ward Industries, a brand of Hart and Cooley, Inc.
 7. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Multi-blade device with radius blades attached to pivoting frame and bracket, steel construction, with push-pull operator strap.

2.2 **BACKDRAFT DAMPERS - METAL**

- A. Manufacturers:
1. Louvers & Dampers, Inc, a brand of Mestek, Inc.
 2. Nailor Industries, Inc.
 3. Ruskin Company, a brand of Johnson Controls.
 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Multi-Blade, Parallel Action Gravity Balanced Backdraft Dampers: Galvanized steel, with center pivoted blades of maximum 6 inch width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.
- C. Backdraft dampers to open at 0.03" static pressure.

2.3 DUCT ACCESS DOORS

- A. Manufacturers:
 - 1. Ductmate Industries, Inc, a DMI Company; _____: www.ductmate.com/#sle.
 - 2. Nailor Industries, Inc.
 - 3. Ruskin Company, a brand of Johnson Controls.
 - 4. SEMCO LLC.
 - 5. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Fabrication: Rigid and close-fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ducts, install minimum 1 inch thick insulation with sheet metal cover.
 - 1. Less Than 12 inches Square: Secure with sash locks.
 - 2. Up to 18 inches Square: Provide two hinges and two sash locks.
 - 3. Up to 24 by 48 inches: Three hinges and two compression latches with outside and inside handles.

2.4 DUCT TEST HOLES

- A. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

2.5 FIRE DAMPERS

- A. Manufacturers:
 - 1. Louvers & Dampers, Inc, a brand of Mestek, Inc.
 - 2. Nailor Industries, Inc.
 - 3. Ruskin Company, a brand of Johnson Controls.
 - 4. Ward Industries, a brand of Hart and Cooley, Inc.
 - 5. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Fabricate in accordance with NFPA 90A and UL 555, and as indicated.
- C. Horizontal Dampers: Galvanized steel, 22 gauge, 0.0299 inch frame, stainless steel closure spring, and lightweight, heat retardant non-asbestos fabric blanket.
- D. Curtain Type Dampers: Galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for horizontal installations. Configure with blades out of air stream except for 1.0 inch pressure class ducts up to 12 inches in height.
- E. Fusible Links: UL 33, separate at 160 degrees F with adjustable link straps for combination fire/balancing dampers.

2.6 FLEXIBLE DUCT CONNECTIONS

- A. Manufacturers:
 - 1. Carlisle HVAC Products; Dynair Connector Plus G90 Steel Offset Seam Neoprene Fabric.
 - 2. Elgen Manufacturing, Inc.
 - 3. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Fabricate in accordance with SMACNA (DCS) and as indicated.
- C. Flexible Duct Connections: Fabric crimped into metal edging strip.
 - 1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz per sq yd.
 - a. Net Fabric Width: Approximately 2 inches wide.

2. Metal: 3 inches wide, 24 gauge, 0.0239 inch thick galvanized steel.

2.7 VOLUME CONTROL DAMPERS

- A. Manufacturers:
 1. Louvers & Dampers, Inc, a brand of Mestek, Inc.
 2. Nailor Industries, Inc.
 3. Ruskin Company, a brand of Johnson Controls.
 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Fabricate in accordance with SMACNA (DCS) and as indicated.
- C. Splitter Dampers:
 1. Material: Same gauge as duct to 24 inches size in either direction, and two gauges heavier for sizes over 24 inches.
 2. Blade: Fabricate of single thickness sheet metal to streamline shape, secured with continuous hinge or rod.
 3. Operator: Minimum 1/4 inch diameter rod in self aligning, universal joint action, flanged bushing with set screw.
- D. Single Blade Dampers:
 1. Fabricate for duct sizes up to 6 by 30 inch.
 2. Blade: 24 gauge, 0.0239 inch, minimum.
- E. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 by 72 inch. Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
 1. Blade: 18 gauge, 0.0478 inch, minimum.
- F. End Bearings: Except in round ducts 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon, thermoplastic elastomer, or sintered bronze bearings.
 1. Manufacturers:
 - a. Carlisle HVAC Products; Dynair End Bearing Leak Resistant Sets.
 - b. Elgen Manufacturing Company, Inc; Snap-in Bushing.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.

2.8 LOW LEAKAGE (CLASS 1A) CONTROL DAMPERS

- A. Manufacturers:
 1. Ruskin Company; CD50: www.ruskin.com/#sle.
- B. Frame:
 1. Material: 12 gauge galvanized steel.
 2. Free-area: Single cross section.
 3. Blanked-off: Split frame into two free-area sections to allow a smaller free-area to be used for a minimum airflow intake or exhaust application and secondary free-area fully blanked-off.
- C. Blade:
 1. Type: Single-blade rectangle shape.
 2. Operation: Opposed type.
 3. Maximum Individual Blade Height: 8 inches.
 4. Material: 12 gauge galvanized steel.
 5. Authority: Opposed type, 5 to 50 percent (typically 10 percent).

2.9 SOUND TRAPS (DUCT SILENCERS)

- A. Sound Traps shall be manufactured by Ruskin or approved equal.
- B. Sound traps shall be rated shall be rated 25 flame-spread and 50 smoke development.
- C. Fabricate outer casing with 0.034 inch solid galvanized steel. Fabricate interior casing with 0.034 galvanized steel with 1/8" perforations.
- D. Fill material to be inert fibrous material with polymer film enclosing fill material.

2.10 STORM LOUVERS

- A. Greenheck Model EDK-402, 4" stationary louver or approved equal.
- B. Frame and Blade Construction: 0.125 inch thick extruded aluminum, 6063-T5 alloy, welded construction.
- C. Provide with 1/2" aluminum mesh, 0.063 inch, birdscreen.
- D. Provide custom color finish, PPG Duranar 2 coat system. Color to be selected by Architect.

PART 3 EXECUTION**3.1 INTERFACE WITH WORK OF OTHER SECTIONS**

- A. Confirm framing and support members.
- B. Confirm rough-in and framing of walls and partitions with supports for equipment and accessories.
- C. Confirm rough-in locations and power requirements before rough-in installation. Refer to Section 26 27 17 - Equipment Wiring.
- D. Confirm rough-in location and signals before rough-in installation. refer to section 23 09 13 - Instrumentation and Control Devices for HVAC.

3.2 EXAMINATION

- A. Verify that surfaces are suitable for installation.
- B. Examine areas to receive equipment for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- C. Verify that piping and equipment are ready to receive work.
- D. Verify field measurements are as shown on shop drawings.
- E. Electrical:
 - 1. Verify electrical power, voltage, phase and current is available and of the correct characteristics.
 - 2. Verify rough-in for electrical connections to verify actual locations before installing.
 - 3. Verify motor type and VFD or disconnect type for compatibility prior to ordering equipment.
- F. Controls:
 - 1. Verify signal power, voltage, phase and current is available and of the correct characteristics.
 - 2. Verify rough-in for control connections to verify actual locations before installing.
 - 3. Verify motor type and VFD or disconnect type for compatibility with control sequence and control devices prior to ordering equipment.

- G. Maintain clearances to combustibles and service clearances.
- H. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

- A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA (DCS). Refer to Section 23 31 00 for duct construction and pressure class.
- B. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.
- C. Provide duct access doors. Review locations prior to fabrication.
 - 1. Provide access doors with a minimum size as indicated.
 - a. In ducts 12 inches or smaller, 8 inches x 8 inches size for hand access.
 - b. In ducts 30 inches or smaller, access door shall be 2" less than the interior duct dimension and square in shape.
 - c. In ducts over 30 inches, 28 inches x 28 inches.
 - 2. Provide access doors for inspection and cleaning at the following locations:
 - a. Before and after filters.
 - b. Before and after coils.
 - c. Fans.
 - d. Automatic Dampers.
 - e. Fire Dampers.
 - f. Combinations Fire and Smoke Dampers.
 - g. Smoke Dampers.
 - h. Elbows.
 - i. Every 25 linear feet for duct cleaning.
 - j. Provide for cleaning kitchen exhaust ducts in accordance with NFPA 96.
- D. Provide fire dampers, combination fire and smoke dampers, and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components, and where required by authorities having jurisdiction.
 - 1. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
 - 2. Install per UL and FM listing to maintain fire rated assembly listed rating.
- E. Flexible Duct Connections:
 - 1. At fans and motorized equipment associated with ducts, provide flexible duct connections immediately adjacent to the equipment.
 - 2. At equipment supported by vibration isolators, provide flexible duct connections immediately adjacent to the equipment. Refer to Section 20 05 48 - Supports for Piping, Ductwork and Equipment.
 - 3. For fans developing static pressures of 5.0 inches and over, cover flexible connections with leaded vinyl sheet, held in place with metal straps.
- F. Balancing Dampers:
 - 1. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing.
 - 2. Install minimum 2 duct widths from duct take-off.
 - 3. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.

END OF SECTION 23 33 00

SECTION 23 36 00**AIR TERMINAL UNITS****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Single-duct terminal units.
 - 1. Single-duct, constant-volume units.

1.2 RELATED REQUIREMENTS

- A. Division 01 - General Requirements
- B. Section 23 09 13 - Instrumentation and Control Devices for HVAC: Thermostats and actuators.
- C. Section 23 09 23 - Direct-Digital Control System for HVAC.
- D. Section 23 21 13 - Hydronic Piping: Connections to heating coils.
- E. Section 23 21 14 - Hydronic Specialties: Connections to heating coils.
- F. Section 23 31 00 - HVAC Ducts and Casings.
- G. Section 23 33 00 - Air Duct Accessories.
- H. Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS

- A. AHRI 410 - Standard for Forced-Circulation Air-Cooling and Air-Heating Coils; 2001 (R2011).
- B. AHRI 880 (I-P) - Performance Rating of Air Terminals; 2011 with Addendum 1.
- C. ASHRAE Std 130 - Methods of Testing Air Terminal Units; 2008 (R2014).
- D. ASTM A492 - Standard Specification for Stainless Steel Rope Wire; 1995 (Reapproved 2013).
- E. ASTM A603 - Standard Specification for Zinc-Coated Steel Structural Wire Rope; 1998 (Reapproved 2014).
- F. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material); 2012.
- G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.
- H. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- I. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2015.
- J. SMACNA (SRM) - Seismic Restraint Manual Guidelines for Mechanical Systems; Sheet Metal and Air Conditioning Contractors' National Association; 2008.
- K. UL 94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances; Current Edition, Including All Revisions.

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- A. Product Data: Provide data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings that indicate air flow, static pressure, and NC designation. Include electrical characteristics and connection requirements.
- B. Certificates: Certify that coils are tested and rated in accordance with AHRI 410.
- C. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists. Include directions for resetting constant-volume regulators.
- D. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.5 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Provide five year manufacturer warranty for air terminal units.

PART 2 PRODUCTS**2.1 SINGLE-DUCT, CONSTANT-VOLUME UNITS**

- A. Manufacturers:
 - 1. Krueger-HVAC: www.krueger-hvac.com/#sle.
 - 2. Price Industries, Inc: www.priceindustries.com/#sle.
- B. Basis of Design: Price Industries, Inc: www.priceindustries.com/#sle.
 - 1. Single-Duct Terminal Unit: SDV, (direct digital controls).
- C. General:
 - 1. Factory-assembled, AHRI 880 (I-P) rated and bearing the AHRI seal, air volume control terminal with damper assembly, flow sensor, externally mounted volume controller, duct collars, and all required features.
 - 2. Control box bearing identification, including but not necessarily limited to nominal cfm, maximum and minimum factory-set airflow limits, coil type and coil (right or left hand) connection, where applicable.
- D. Unit Casing:
 - 1. Minimum 22 gauge, 0.0299 inch galvanized steel.
 - 2. Air Inlet Collar: Provide round, suitable for standard flexible duct sizes.
 - 3. Unit Discharge: Rectangular, with slip-and-drive connections.
 - 4. Acceptable Liners:
 - a. 1/2 inch thick, coated, fibrous-glass complying with ASTM C1071.
 - 1) Secure with adhesive.
 - 2) Coat edges exposed to airstream with NFPA 90A approved sealant.
 - 3) Cover liner with non-porous foil.
 - b. Liner not to contain pentabrominated diphenyl ether (CAS #32534-81-9) or octabrominated diphenyl ether.
- E. Damper Assembly:
 - 1. Heavy-gauge, galvanized steel or extruded aluminum construction with solid steel, nickel-plated shaft pivoting on HDPE, self-lubricating bearings.

2. Provide integral position indicator or alternative method for indicating damper position over full range of 90 degrees.
 3. Incorporate low leak damper blades for tight airflow shutoff.
- F. Hot Water Heating Coil:
1. Coil Casing: Minimum 22 gauge, 0.0299 inch galvanized steel, factory-installed on terminal discharge with rectangular outlet, duct connection type.
 2. Coil Fins: Aluminum or aluminum plated fins, mechanically-bonded to seamless copper tubes.
 3. Coil leak tested to minimum 350 psig.
 4. Base performance data on tests run in accordance with AHRI 410 and units to bear AHRI 410 label.
- G. Controls:
1. Electronic:
 - a. Damper Actuator: 24 volt, power closed, spring return open.
 - b. Velocity Controller:
 - 1) Settings for minimum/maximum air volumes, factory-calibrated, and field adjustable at thermostat.
 - 2) Maintain constant airflow dictated by thermostat to within 5 percent of set point while compensating for inlet static-pressure variations up to 4 inch wg, when tested in accordance with ASHRAE Std 130.
 - 3) Provide controller with multi-point with velocity sensors located in air inlets and outlet.
 - c. Thermostat: Wall-mounted, time-proportional with reheat-coil control including a temperature set-point display in Celsius and Fahrenheit.
 - d. See Sections 25 1400, 25 3513, and 25 3516.
 2. DDC (Direct-Digital Controls):
 - a. Basis of Design: Price Industries, Inc; Price Intelligent Controller: www.priceindustries.com/#sle.
 - 1) The unit level controller to include the following:
 - (a) 24 VAC power terminal or RJ-12 Power connection.
 - (b) T-Stat Port for thermostat connection.
 - (c) Service Port for Price Linker diagnostic equipment.
 - (d) Damper actuator.
 - (e) Fan output connection.
 - (f) LED indication for troubleshooting.
 - (g) Three binary staged heating outputs.
 - (h) Binary cooling output.
 - (i) S.A.T. sensor input.
 - (j) Contact closure input.
 - (k) Four analog outputs.
 - b. Bi-directional Damper Actuator: 24 volt, powered closed, spring return open.
 - c. Microprocessor-Based Controller: Air volume controller, pressure-independent with electronic airflow transducers, factory-calibrated maximum and minimum CFM's.
 - 1) Occupied and unoccupied operating mode.
 - 2) Remote reset of temperature or CFM set points.
 - 3) Proportional, plus integral control of room temperature.
 - 4) Monitoring and adjusting with portable terminal.
 - d. Room Sensor:
 - 1) Compatible with temperature controls specified.
 - 2) Wall-mounted, system powered, with temperature set-point adjustment including connection access for portable operator terminal.
 - e. See Section 25 1400.

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3. Airflow Sensor: Differential pressure airflow device measuring total, static, and wake pressures.
 - a. Basis of Design: Price Industries, Inc; SP300 Air Flow Sensor: www.priceindustries.com/#sle.
 - 1) Plastic parts are fire-resistant, complying with UL 94.
 - 2) Provides accuracy within 5 percent with a 90 degree sheet metal elbow directly at the inlet of the assembly.
 - 3) Control tubing is protected by grommets at the wall of the air flow sensor's housing.
 - 4) Furnished with twelve total pressure sensing ports and a center averaging chamber that amplifies the sensed air flow signal.
 - 5) Provide velocity pressure sensor with a removable access section for maintenance.
 - b. Signal accuracy: Plus/minus five percent throughout terminal operating range.
4. Control Sequence:
 - a. Suitable for operation with duct pressures between 0.25 and 3.0 inch wg inlet static pressure.
 - b. Include factory-mounted and piped, 5-micron filter; and adjustable, velocity-resetting, high-limit control with amplifying relay.
 - c. See Section 23 09 93.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that conditions are suitable for installation.
- B. Verify that field measurements are as indicated on drawings.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install the inlets of air terminal units and air flow sensors a minimum of four duct diameters from elbows, transitions, and duct takeoffs.
- C. See drawings for the size(s) and duct location(s) of the air terminal units.
- D. Provide ceiling access doors or locate units above easily removable ceiling components.
- E. Support units individually from structure with wire rope complying with ASTM A492 and ASTM A603 in accordance with SMACNA (SRM). See Section 23 05 48.
- F. Do not support from ductwork.
- G. Connect to ductwork in accordance with Section 23 31 00.
- H. Verify that electric power is available and of the correct characteristics.

3.3 CLOSEOUT ACTIVITIES

- A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.

END OF SECTION 23 36 00

SECTION 23 52 16**CONDENSING BOILERS****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Condensing Boiler.
- B. Manufactured Units.
- C. Boiler Construction.
- D. Boiler Trim.
- E. Fuel Burning System.
- F. Factory Installed Controls.

1.2 RELATED REQUIREMENTS

- A. Division 01 - General Requirements
- B. Section 23 09 13 - Instrumentation and Control Devices for HVAC.
- C. Section 23 21 14 - Hydronic Specialties.
- D. Section 23 21 23 - Hydronic Pumps.
- E. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- F. Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS

- A. ANSI Z21.13 - American National Standard for Gas-Fired Low-Pressure Steam and Hot Water Boilers; 2012.
- B. ASHRAE Std 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings; 2013, Including All Addenda.
- C. ASME BPVC-IV - Boiler and Pressure Vessel Code, Section IV - Rules for Construction of Heating Boilers; 2015.
- D. NFPA 54 - National Fuel Gas Code; 2015.

1.4 SUBMITTALS

- A. Listed manufacturers and series are for reference only and do not promote any single product. Series are provided for reference, and should not be used as an ordering model number. Accessories and options may be custom components purchased separately.
- B. Product Data: Provide data indicating general assembly, components, controls, safety controls, and wiring diagrams with electrical characteristics and connection requirements, and service connections.
 - 1. Include rated capacities, operating characteristics, furnished specialties, and accessories.
 - 2. Include mounting brackets, control panels, thermostat and options.
 - 3. Include wiring diagrams: Power, signal and control wiring.
 - 4. Condensing Boiler (23 52 16 - 001 - A)

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- C. Manufacturer's Installation Instructions: Indicate assembly, support details, connection requirements, and include start up instructions.
- D. Manufacturer's Factory Inspection Report: Submit boiler inspection prior to shipment.
- E. Manufacturer's Field Reports: Burner manifold gas pressure, percent carbon monoxide (CO), percent oxygen (O), percent excess air, flue gas temperature at outlet, ambient temperature, net stack temperature, percent stack loss, percent combustion efficiency, and heat output.
 - 1. Indicate compliance with specified performance and efficiency.
 - 2. Provide results of the following combustion tests:
 - a. Boiler firing rate.
 - b. Burner manifold gas pressure.
- F. Start-up Report: Indicate start-up results.
 - 1. Condensing Boiler (23 52 16 - 002 - A)
- G. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.
 - 1. Submit under Operation and Maintenance Data books
 - 2. Condensing Boiler.
- H. Project Record Documents: Record actual locations of components and locations of access doors in radiation cabinets required for access or valving.
 - 1. Refer to Section 01 78 00 - Closeout Submittals.
- I. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listings.
 - 1. Refer to Section 01 78 00 - Closeout Submittals.
- J. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, cleaning procedures, replacement parts list, and maintenance and repair data.
- K. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.5 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. Provide 5 year warranty, including parts, materials and labor for defective parts, for the following:
 - 1. Include in Closeout Submittals Book.
 - 2. Condensing Boiler.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect boilers from damage by leaving factory inspection openings and shipping packaging in place until final installation.

PART 2 PRODUCTS**2.1 MANUFACTURERS**

- A. Natural Gas for Indoor Applications:
 - 1. Burnham Alpine.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 MANUFACTURED UNITS

- A. Factory assembled, factory fire-tested, self-contained, readily transported unit ready for automatic operation except for connection of water, fuel, electrical, and vent services.
- B. Unit: Metal membrane wall, water or fire tube, condensing boiler on integral structural steel frame base with integral fuel burning system, firing controls, boiler trim, insulation, and removable jacket, suitable for indoor application.

2.3 BOILER CONSTRUCTION

- A. Comply with the minimum requirements of ASME BPVC-IV and ANSI Z21.13 for construction of boilers.
- B. Assembly to bear the ASME "H" stamp and comply with the efficiency requirements of the latest edition of ASHRAE Std 90.1.
- C. Heat Exchanger: Construct with materials that are impervious to corrosion where subject to contact with corrosive condensables.
- D. Provide adequate tappings, observation ports, removable panels, and access doors for entry, cleaning, and inspection.
- E. Insulate casing with insulation material, protected and covered by heavy-gauge metal jacket.
- F. Factory apply boiler base and other components that are subject to corrosion, with durable, powder coated finish.

2.4 BOILER TRIM

- A. ASME rated pressure relief valve.
- B. Flow switch.
- C. Electronic Low Water Cut-off: Complete with test light and manual reset button to automatically prevent firing operation whenever boiler water falls below safe level.
- D. Temperature and pressure gauge.
- E. Pressure Switches:
 - 1. High gas pressure.
 - 2. Low gas pressure.
 - 3. Air pressure.
- F. Manual reset high limit.
- G. Boiler Pump (where required by boiler design):
 - 1. Where pump is not provided by boiler manufacturer, provide pump in accordance with boiler manufacturer's recommendations.
 - 2. Pump time delay.

2.5 FUEL BURNING SYSTEM

- A. Provide forced draft automatic burner or pulse combustion, integral to boiler, designed to burn natural gas, propane, and No. 2 fuel oil, and maintain fuel-air ratios automatically.
 - 1. Blower Design: Statically and dynamically balanced to supply combustion air; direct connected to motor.
 - 2. Forced Draft Design: Mixes combustion air and gas to achieve 90 percent combustion efficiency.

3. Pulse Combustion Design: Self-aspirating, not requiring blower for combustion.
 4. Combustion Air Filter: Protects fuel burning system from debris.
- B. Gas Train: Plug valve, safety gas valve, gas-air ratio control valve, and pressure regulator controls air and gas mixture.
- C. Intakes: Combustion air intake capable of accepting free mechanical room air or direct outside air through a sealed intake pipe.

2.6 FACTORY INSTALLED CONTROLS

- A. Option for internal or external (0-10) VDC control.
- B. Temperature Controls:
1. Automatic reset type to control fuel burning system on-off and firing rate to maintain temperature.
 2. Manual reset type to control fuel burning system to prevent boiler water temperature from exceeding safe system water temperature.
 3. Low-fire start time delay relay.
- C. Electronic PI setpoint/modulation control system.
- D. Microprocessor-based, fuel/air mixing controls.

PART 3 EXECUTION

3.1 INTERFACE WITH WORK OF OTHER SECTIONS

- A. Confirm framing and support members.
- B. Confirm rough-in and framing of walls and partitions with supports for equipment and accessories.
- C. Confirm rough-in locations and fuel gas requirements before rough-in installation. Refer to Section 20 00 00 - Common Work Results.
- D. Confirm rough-in locations and power requirements before rough-in installation. Refer to Section 23 09 23 - Direct-Digital Control System for HVAC.
- E. Confirm rough-in locations and power requirements before rough-in installation. Refer to Section 26 27 17 - Equipment Wiring.

3.2 EXAMINATION

- A. Verify that surfaces are suitable for installation.
- B. Verify that field measurements are as shown on the drawings.
- C. Examine areas to receive equipment for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- D. Electrical:
1. Verify electrical power, voltage, phase and current is available and of the correct characteristics.
 2. Verify rough-in for electrical connections to verify actual locations before installing.
 3. Verify motor type and VFD or disconnect type for compatibility prior to ordering equipment.
- E. Controls:
1. Verify signal power, voltage, phase and current is available and of the correct characteristics.

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2. Verify rough-in for control connections to verify actual locations before installing.
 3. Verify motor type and VFD or disconnect type for compatibility with control sequence and control devices prior to ordering equipment.
- F. Maintain clearances to combustibles and service clearances.
- G. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

- A. Install in accordance with the following:
1. Federal, state and local codes.
 2. Manufacturer's instructions.
 3. NFPA 90A.
 4. NFPA 70 - National Electric Code.
- B. Install equipment level and plumb.
- C. Connect wiring according to Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
- D. Ground equipment according to Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- E. Install boiler and provide connection of natural gas service in accordance with requirements of NFPA 54 and applicable codes.
- F. Install boiler on concrete housekeeping base, sized minimum of 4 inches larger than boiler base in accordance with Section 03 30 00 - Cast-In-Place Concrete.
- G. Coordinate factory installed controls with Section 23 09 13 - Instrumentation and Control Devices for HVAC.
- H. Pipe relief valves to nearest floor drain.
- I. Pipe cooled condensate produced by the combustion process from the boiler condensate connection and/or flue stack with suitable piping material to neutralizer prior to discharging into nearest floor drain.
- J. Install primary boiler pump in accordance with Section 23 21 23 - Hydronic Pumps.
- K. Provide piping connection and accessories in accordance with Section 23 21 14 - Hydronic Specialties.
- L. Provide for connection to electrical service in accordance with Section 26 27 17 - Equipment Wiring.

3.4 START-UP

- A. Perform start-up per manufacturer's standard procedure.
1. Condensing Boiler.

3.5 TRAINING

- A. Perform training in accordance with manufacturer's standard procedure.
1. Condensing Boiler.

3.6 CLOSEOUT ACTIVITIES

- A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.
- B. See Section 01 79 00 - Demonstration and Training, for additional requirements.

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- C. Demonstrate proper operation of equipment to Owner's designated representative.
- D. Demonstration: Demonstrate operation of system to Owner's personnel.
 - 1. Use operation and maintenance data as reference during demonstration.
 - 2. Conduct walking tour of project.
 - 3. Briefly describe function, operation, and maintenance of each component.
- E. Training: Train Owner's personnel on operation and maintenance of system.
 - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 - 2. Provide minimum of two hours of training.
 - 3. Instructor: Manufacturer's training personnel.
 - 4. Location: At project site.

END OF SECTION 23 52 16

SECTION 23 73 13**MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Casing construction.
- B. Fan section.
- C. Coil section.
- D. Filter and air cleaner section.

1.2 RELATED REQUIREMENTS

- A. Division 01 - General Requirements
- B. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC.
- C. Section 23 33 00 - Air Duct Accessories: Flexible duct connections.
- D. Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS

- A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; 2015.
- B. ACGIH - Ultraviolet Radiation, TLV Physical Agents; 2010, 7th edition.
- C. AHRI 410 - Standard for Forced-Circulation Air-Cooling and Air-Heating Coils; 2001 (R2011).
- D. AHRI 430 (I-P) - Performance Rating of Central Station Air-Handling Units; 2014.
- E. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating; 2012.
- F. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size; 2012, with 2015 amendments.
- G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- H. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2015.
- I. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005.
- J. UL (DIR) - Online Certifications Directory; current listings at database.ul.com.

1.4 SUBMITTALS

- A. Listed manufacturers and series are for reference only and do not promote any single product. Series are provided for reference, and should not be used as an ordering model number. Accessories and options may be custom components purchased separately.
- B. Product Data: Provide manufacturer's catalog sheet for equipment indicating rough-in size, finish, and accessories. Manufacturer's data sheets on each item of equipment and device, marked up to identify the items to be used on the project.

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1. Published Literature: Indicate dimensions, weights, capacities, ratings, gauges and finishes of materials, and electrical characteristics and connection requirements.
 2. Filters: Data for filter media, filter performance data, filter assembly, and filter frames.
 3. Fans: Performance and fan curves with specified operating point clearly plotted, power, RPM.
 4. Electrical Requirements: Power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.
- C. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.
1. Submit under Operation and Maintenance Data books
 2. AHU.
- D. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.
- E. Executed Warranty: Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.
- F. Manufacturer's Instructions: Include installation instructions.
- G. Maintenance Data: Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.
- H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
1. See Section 01 60 00 - Product Requirements, for additional provisions.
 2. Extra Fan Belts: One set for each unit.
 3. Extra Filters: One set for each unit.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.
- B. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.
- C. Do not operate units until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.7 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Provide minimum two year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS**2.1 MANUFACTURERS**

- A. Daikin Applied.

- B. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 REGULATORY REQUIREMENTS

- A. Comply with NFPA 70.
- B. Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for the purpose specified and indicated.

2.3 CASING CONSTRUCTION

- A. Full Perimeter Base Rail:
1. Construct of galvanized steel.
 2. Provide base rail of sufficient height to raise unit for external trapping of condensate drain pans.
- B. Casing:
1. Construct of one piece, insulated, double wall panels.
 2. Provide mid-span, no through metal, internal thermal break.
 3. Construct outer panels of galvanized steel and inner panels of galvanized steel.
 4. Casing Air Pressure Performance Requirements:
 - a. Able to withstand up to 8 inches w.g. positive or negative static pressure.
 - b. Not to exceed 0.0042 inches per inch deflection at 1.5 times design static pressure up to a maximum of plus 8 inches w.g. in positive pressure sections and minus 8 inches w.g. in negative pressure sections.
- C. Access Doors:
1. Construction, thermal and air pressure performance same as casing.
 2. Provide surface mounted handles on hinged, swing doors.
- D. Casing Leakage: Seal joints and provide airtight access doors so that air leakage does not exceed one percent of design flow at the specified casing pressure.
- E. Insulation:
1. Provide minimum thermal thickness of 12 R throughout.
 2. Completely fill panel cavities in each direction to prevent voids and settling.
 3. Comply with NFPA 90A.
- F. Drain Pan Construction:
1. Provide cooling coil with an insulated, double wall, stainless steel drain pan complying with ASHRAE 62.1 for indoor air quality and sufficiently sized to collect all condensate.
 2. Slope in two planes to promote positive drainage and eliminate stagnate water conditions.
 3. Locate outlet of sufficient diameter at lowest point of pan to prevent overflow at normal operating conditions.
 4. Provide threaded drain connections constructed of drain pan material, extended sufficient distance beyond the base to accommodate field installed, condensate drain trapping.
- G. Finish:
1. Indoor Units:
 - a. Provide exterior, galvanized steel panels with painted surface complying with ASTM B177/B177M.
 - b. Color: Manufacturer's standard color.

2.4 FAN SECTION

- A. Type: Forward curved, single width, single inlet, centrifugal plug type fan, in compliance with AMCA 99. Refer to Section 23 34 13.
- B. Performance Ratings: Determined in accordance with AMCA 210 and labeled with AMCA Certified Rating Seal.
- C. Sound Ratings: AMCA 301; tested to AMCA 300 and label with AMCA Certified Sound Rating Seal.
- D. Bearings: Self-aligning, grease lubricated, with lubrication fittings extended to exterior of casing with plastic tube and grease fitting rigidly attached to casing.
- E. Mounting:
 - 1. Locate fan and motor internally on welded steel base coated with corrosion resistant paint.
 - 2. Factory mount motor on slide rails.
 - 3. Provide access to motor, drive, and bearings through removable casing panels or hinged access doors.
 - 4. Mount base on vibration isolators.
- F. External Motor Junction Box: Factory mount NEMA 4 external junction box and connect to extended motor leads from internally mounted motors.
- G. Motor Wiring Conduit: Factory wire fan motor wiring to the unit mounted starter-disconnect.
- H. Flexible Duct Connections:
 - 1. For separating fan, coil, and adjacent sections.
- I. Drives:
 - 1. Comply with AMCA 99.
 - 2. Bearings: Heavy duty pillow block type, ball bearings, with ABMA STD 9, L-10 life at 50,000 hours.
 - 3. Shafts: Solid, hot rolled steel, ground and polished, with key-way, and protectively coated with lubricating oil.
 - 4. V-Belt Drive: Cast iron or steel sheaves, dynamically balanced, bored to fit shafts, and keyed. Variable and adjustable pitch sheaves for motors 15 hp and under selected so required rpm is obtained with sheaves set at mid-position; fixed sheave for 20 hp and over, matched belts, and drive rated as recommended by manufacturer or minimum 1.5 times nameplate rating of the motor.
 - 5. Belt Guard: Fabricate to SMACNA (DCS); 0.106 inch thick, 3/4 inch diamond mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation, with provision for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

2.5 COIL SECTION

- A. Casing: Provide access to both sides of coils. Enclose coils with headers and return bends exposed outside casing. Slide coils into casing through removable end panel with blank off sheets and sealing collars at connection penetrations.
- B. Drain Pans: 24 inch downstream of coil and down spouts for cooling coil banks more than one coil high.
- C. Air Coils:
 - 1. Certify capacities, pressure drops, and selection procedures in accordance with AHRI 410.
- D. Fabrication:

1. Tubes: 5/8 inch OD seamless copper expanded into fins, brazed joints.
2. Fins: Aluminum.
3. Casing: Die formed channel frame of galvanized steel.

2.6 FILTER AND AIR CLEANER SECTION

- A. General: Provide filter sections with filter racks, minimum of one access door for filter removal, and filter block-offs to prevent air bypass.
- B. Pleated Media Filters:
 1. Media: 4 inch, 100 percent synthetic fibers, continuously laminated to a grid with water repellent adhesive, and capable of operating up to a maximum of 625 fpm without loss of efficiency and holding capacity.
 2. Frame: Steel wire grid.
 3. Minimum Efficiency Reporting Value: MERV 8 when tested in accordance with ASHRAE Std 52.2.
- C. Differential Pressure Gauge:
 1. Provide factory installed dial type differential pressure gauge, flush mounted with casing outer wall, and fully piped to both sides of each filter to indicate status.
 2. Maintain plus/minus 5 percent accuracy within operating limits of 20 degrees F to 120 degrees F.

2.7 ACCESS SECTION

- A. Provide where indicated on drawings to allow for inspection, cleaning, and maintenance of field-installed components.
- B. Construct access doors same as previously specified within this Section.

PART 3 EXECUTION

3.1 INTERFACE WITH WORK OF OTHER SECTIONS

- A. Confirm framing and support members.
- B. Confirm rough-in and framing of walls and partitions with supports for equipment and accessories.
- C. Confirm rough-in locations and power requirements before rough-in installation. Refer to Section 26 27 17 - Equipment Wiring.
- D. Confirm rough-in location and signals before rough-in installation. refer to section 23 09 13 - Instrumentation and Control Devices for HVAC.

3.2 EXAMINATION

- A. Verify that surfaces are suitable for installation.
- B. Examine areas to receive equipment for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- C. Verify that piping and equipment are ready to receive work.
- D. Verify field measurements are as shown on shop drawings.
- E. Electrical:
 1. Verify electrical power, voltage, phase and current is available and of the correct characteristics.
 2. Verify rough-in for electrical connections to verify actual locations before installing.
 3. Verify motor type and VFD or disconnect type for compatibility prior to ordering equipment.

- F. Controls:
 - 1. Verify signal power, voltage, phase and current is available and of the correct characteristics.
 - 2. Verify rough-in for control connections to verify actual locations before installing.
- G. Maintain clearances to combustibles and service clearances.
- H. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Bolt sections together with gaskets.
- C. Isolate fan section with flexible duct connections.
- D. Install flexible duct connections between fan inlet and discharge ductwork and air handling unit sections. Ensure that metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running.
- E. Install assembled unit on vibration isolators. Install isolated fans with resilient mountings and flexible electrical leads. Install restraining snubbers as indicated. Refer to Section 23 05 48. Adjust snubbers to prevent tension in flexible connectors when fan is operating.
- F. Provide fixed sheaves required for final air balance.
- G. Insulate coil headers located outside air flow as specified for piping. Refer to Section 23 07 16.

3.4 SYSTEM STARTUP

- A. Provide manufacturer's field representative to perform systems startup.
- B. Prepare and start equipment and systems in accordance with manufacturers' instructions and recommendations.
- C. Adjust for proper operation within manufacturer's published tolerances.

3.5 CLOSEOUT ACTIVITIES

- A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.
- B. See Section 01 79 00 - Demonstration and Training, for additional requirements.
- C. Demonstrate proper operation of equipment to Owner's designated representative.
- D. Demonstration: Demonstrate operation of system to Owner's personnel.
 - 1. Use operation and maintenance data as reference during demonstration.
 - 2. Conduct walking tour of project.
 - 3. Briefly describe function, operation, and maintenance of each component.
- E. Training: Train Owner's personnel on operation and maintenance of system.
 - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 - 2. Provide minimum of two hours of training.
 - 3. Instructor: Manufacturer's training personnel.

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4. Location: At project site.

END OF SECTION 23 73 13

SECTION 23 82 00**CONVECTION HEATING AND COOLING UNITS****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Cabinet Unit Heaters.
- B. Fan-coil Units.

1.2 RELATED REQUIREMENTS

- A. Division 01 - General Requirements
- B. Section 23 09 13 - Instrumentation and Control Devices for HVAC.
- C. Section 23 09 23 - Direct-Digital Control System for HVAC.
- D. Section 23 21 13 - Hydronic Piping.
- E. Section 23 21 14 - Hydronic Specialties.
- F. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

1.3 REFERENCE STANDARDS

- A. AHRI Directory of Certified Product Performance - Air-Conditioning, Heating, and Refrigeration Institute (AHRI); current edition at www.ahrinet.org.
- B. AHRI 440 - Performance Rating of Room Fan-Coil Units; 2008.
- C. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2013.
- D. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2014.
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2015.

1.4 SUBMITTALS

- A. Listed manufacturers and series are for reference only and do not promote any single product. Series are provided for reference, and should not be used as an ordering model number. Accessories and options may be custom components purchased separately.
- B. Product Data: Provide manufacturer's most current catalog data sheet for equipment indicating rough-in size, finish, and accessories. Manufacturer's data sheets on each item of equipment and device, shall be clearly marked up to identify the items, accessories and options to be used on the project.
 - 1. Include rated capacities, operating characteristics, furnished specialties, and accessories.
 - 2. Include mounting brackets, control panels, thermostat and options.
 - 3. Include wiring diagrams: Power, signal and control wiring.
 - 4. Cabinet Unit Heaters (23 82 39.16 - 004 - A)
 - 5. Fan Coil Unit (23 82 39.16 - 006 - A)

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- C. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listings.
 - 1. Refer to Section 01 78 00 - Closeout Submittals.

1.5 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.1 SEE SECTION 01 60 00 FOR ADDITIONAL REQUIREMENTS.

2.2 HYDRONIC CABINET UNIT HEATERS.

- A. Manufacturers:
 - 1. Daikin.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Provide products listed, classified, and labeled by Underwriters Laboratories Inc. (UL), Intertek (ETL), or testing firm acceptable to Authority Having Jurisdiction as suitable for the purpose indicated.
- C. Coils:
 - 1. Evenly spaced aluminum fins mechanically bonded to copper tubes.
 - 2. Heating Hot Water: Suitable for working temperatures up to a maximum not less than 200 degrees F.
- D. Cabinet: Minimum 16 gauge, 0.0598 inch thick sheet steel front panel with exposed corners and edges rounded, easily removed panels, glass fiber insulation, integral air outlet, and inlet grilles.
- E. Finish: Factory applied baked primer coat on visible surfaces of enclosure or cabinet.
- F. Fans: Centrifugal forward-curved double-width wheels, statically and dynamically balanced, direct driven.
- G. Motor: Tap wound multiple speed permanent split capacitor with sleeve bearings, resiliently mounted.
- H. Control: Factory wired, solid state, infinite speed control, located in cabinet.
- I. Filter: Easily removed, 1 inch thick glass fiber throw-away type, located to filter air before coil.

2.3 FAN-COIL UNITS

- A. Manufacturers:
 - 1. Vertical Cabinet, Horizontal Exposed, or Horizontal Recessed:
 - a. Daikin Applied.
- B. Performance Data and Safety Requirements:
 - 1. Unit capacities certified in accordance with AHRI 440.
 - 2. Provide products listed, classified, and labeled by Underwriters Laboratories Inc. (UL), Intertek (ETL), or testing firm acceptable to Authority Having Jurisdiction as suitable for the purpose indicated.
 - 3. Insulation to comply with NFPA 90A requirements for flame spread and smoke generation.
 - 4. Equipment wiring to comply with requirements of NFPA 70.
- C. Required Directory Listings: AHRI Directory of Certified Product Performance - Air-Conditioning, Heating, and Refrigeration Institute (AHRI).

- D. Coils:
 - 1. Evenly spaced aluminum fins mechanically bonded to copper tubes.
 - 2. Water Coil: Suitable for working temperatures not less than 200 degrees F.
 - 3. Provide drain pan under cooling coil easily removable for cleaning.
- E. Vertical Cabinet and Horizontal Exposed Units: Minimum 18 gauge, 0.0478 inch thick sheet steel with exposed corners and edges rounded, easily removed panels, glass fiber insulation, integral air outlet, and inlet grilles.
- F. Horizontal Recessed Units:
 - 1. Provide with a galvanized steel cabinet, easily removed panels, glass fiber insulation, integral air outlet, and inlet grilles with minimum 18 gauge, 0.0478 inch thick sheet steel bottom panel.
 - 2. Ducted Units: Provide with air inlet and outlet duct collars.
- G. Vertical Stack Units:
 - 1. Minimum 18 gauge, 0.0478 inch thick sheet steel with exposed corners and edges rounded, easily removed panels, glass fiber insulation, aluminum double-deflection discharge grille and panel-type return grille.
 - 2. Provide maintenance access via return grille.
- H. Finish: Factory applied baked primer coat on visible surfaces of enclosure or cabinet.
- I. Fans: Centrifugal forward-curved double-width wheels, statically and dynamically balanced, direct driven.
- J. Motor: Tap wound multiple speed permanent split capacitor with sleeve bearings, resiliently mounted. Refer to section 20 05 13 - Common Motor Requirements.
- K. Filter: Easily removed 1 inch thick glass fiber throw-away type, located to filter air before coil.

PART 3 EXECUTION

3.1 INTERFACE WITH WORK OF OTHER SECTIONS

- A. Confirm framing and support members.
- B. Confirm rough-in and framing of walls and partitions with supports for equipment and accessories.

3.2 EXAMINATION

- A. Verify that surfaces are suitable for installation.
- B. Verify that field measurements are as indicated on drawings.
- C. Examine areas to receive equipment for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- D. Controls:
 - 1. Verify signal power, voltage, phase and current is available and of the correct characteristics.
 - 2. Verify rough-in for control connections to verify actual locations before installing.
- E. Maintain clearances to combustibles and service clearances.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

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3.3 INSTALLATION

- A. Install in accordance with the following:
 - 1. Federal, state and local codes.
 - 2. Manufacturer's instructions.
 - 3. NFPA 90A.
- B. Install equipment level and plumb.
- C. Convectors:
 - 1. Install where indicated.
- D. Cabinet Unit Heaters:
 - 1. Install as indicated.
 - 2. Coordinate to ensure correct recess size for recessed units.
- E. Fan-Coil Units:
 - 1. Install as indicated.
 - 2. Coordinate to ensure correct recess size for recessed units.
- F. Units with Hydronic Coils:
 - 1. Provide with shut-off valve on supply piping and tamper-proof, balancing valve with memory stop on return piping.
 - 2. If not easily accessible, extend air vent to exterior surface of cabinet for ease of servicing.
 - 3. Provide float operated automatic air vents with stop valve for hot water coils.

3.4 CLOSEOUT ACTIVITIES

- A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.

END OF SECTION 23 82 00

SECTION 26 01 00**GENERAL ELECTRICAL REQUIREMENTS****PART 1 GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes general administrative and procedural requirements for electrical installations. The following administrative and procedural requirements are included in this Section to expand the requirements as defined by Part 1 paragraph "Related Documents" :

1. General.
 - a. Definitions.
 - b. Abbreviations.
 - c. Regulations.
 - d. Drawings and Specifications.
 - e. Familiarity with Contract Requirements.
 - f. Submittals.
 - g. Substitutions.
 - h. Electronic Drawings.
 - i. Quality Control.
 - j. Delivery, Storage And Handling.
 - k. Extra Materials.
2. Administrative Submittals.
 - a. Schedule of Values (Detailed Breakdown).
 - b. Record Documents.
 - c. Operation and Maintenance (O&M) Manuals.
3. Execution.
 - a. General Requirements.
 - b. Rough-In.
 - c. Electrical Installations.
 - d. Mounting Heights.
 - e. Cutting and Patching.
 - f. Continuity of Service.
 - g. Protection of Work, Materials, and Equipment.
 - h. Recycling and Disposal of Hazardous/Contaminated Material.
 - i. Start-up and Testing.
 - j. Clean Up.
 - k. Project Safety.
 - l. Instructions for the Owner's Personnel.

- B. Related Sections: See other Division 26 and related Sections for related electrical Work.

1.3 DEFINITIONS

- A. Approved Equal: The term "approved equal", "approved", "equal", "equivalent", etc. shall mean equal in all respects in the opinion of the Engineer.

- B. As Required: The term "as required" refers to making final connections to and/or coordinating with the appropriate authorities regarding the installation of the indicated equipment.
- C. Contract Document(s): The term "contract document(s)" shall mean the entire body of specifications, drawings, addenda, bulletins, response to request for information (RFIs), change orders (CO), construction directives, and other definitive data including correspondence issued during Bidding and after Contract signing as a clarification / change to the Project.
- D. Contractor: The term "Contractor", "this Contractor" or "Electrical Contractor" when used in the Contract Documents refers to the Contractor responsible for all work specified in Division 26 and other divisions and as indicated on the Contract Drawings.
- E. Directed: Terms such as "directed," "requested," "authorized," "selected," and "permitted" when used separately without referencing any authority, shall mean directed by the Engineer, requested by the Engineer, and similar phrases.
- F. Finished/Unfinished Space: The term "finished space" shall mean areas where one or more of the following are applicable: wall coverings (i.e. plaster/gypsum board, wallboard, wall paper, vinyl, trim, etc.) are installed and/or walls are painted, or where floors are polished and/or coverings (i.e. tile, vinyl, carpet, trim, etc.) are installed on the floor, or where ceiling coverings (i.e. plaster/gypsum board, suspended A.C.T., trim, etc.) are installed and/or ceilings are painted. The term "unfinished space" refers to any area that does not meet one of the definitions for a "finished space" as specified above. Mechanical rooms, electrical rooms, garages, etc. are typically considered "unfinished spaces" unless they also double as an office, clean storage, etc.
- G. Furnish: The term "furnish" when used separately, shall mean to supply and deliver to the Project site, ready for assembly, installation, and similar operations by others. Furnishing operations at the Project site shall include, but may not be limited to, the actual unloading, temporary storage, and unpacking of the furnished items.
- H. Indicated: The term "indicated", "shown," "noted," "scheduled," and "specified" refers to graphic representations, notes, or schedules on the Drawings; or to other paragraphs or schedules in the Specifications and similar requirements in the Contract Documents.
- I. Install: The term "install" when used separately, shall mean to mount in place, connect and make operable. Installation operations at the Project site shall include, but may not be limited to, the actual unloading, temporary storage, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
- J. Project: The term "project" when used in these Contract Documents includes the entire project under the total of all Contracts.
- K. Provide: The term "provide" when used in these specifications, shall mean to furnish and install, complete and ready for the intended use. See above definitions for additional requirements.
- L. Regulations: The term "regulations" includes laws, ordinances, codes, industry standards, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.
- M. Subcontractor: The term "Subcontractor" when used in these Contract Documents refers to an experienced installer (i.e. manufacturer, vendor, etc.) whom has successfully completed a minimum of five (5) previous projects similar in size and scope to this Project; being familiar with the special requirements indicated; and having complied with requirements of authorities having jurisdiction. Any reference to, or letting of work contained in these Contract Documents to any Subcontractor does not

relieve this Contractor of his/her responsibility for all work, material and equipment indicated in these Contract Documents.

- N. Work: The term "work" refers to all labor and materials provided by the Contractor and/or Subcontractor to make a complete and operable system.

1.4 ABBREVIATIONS

- A. Abbreviations and Names: The following acronyms or abbreviations as referenced in the Contract Documents are defined to mean the following:

1. A.D.A - Americans with Disabilities Act
2. A.N.S.I. - American National Standards Institute, Inc.
3. A.S.T.M. - American Society for Testing and Materials
4. E.C. - Electrical Contractor
5. G.C. - General Contractor or
6. H.C. - Mechanical Contractor, HVAC Contractor, Heating Contractor
7. I.E.E.E. - Institute of Electrical and Electronic Engineers
8. I.P.C.E.A. - Insulated Power Cable Engineers Association
9. I.S.A. - Instrument Society of America
10. N.E.C. - National Electrical Code of National Fire Protection Association
11. N.E.M.A. - National Electrical Manufacturers Association
12. N.E.S.C. - National Electrical Safety Code
13. N.F.P.A. - National Fire Protection Association
14. P.C. - Plumbing Contractor

1.5 PROJECT REQUIREMENTS

- A. General: All items of labor, materials and equipment, not specified in detail or shown on drawings but necessary for complete installation and proper operation of Work described or implied, shall be furnished and installed.
- B. Testing: Test all electrical conductors, after completion of installation of wiring and apparatus, to insure continuity, proper splicing, freedom from grounds, except "made grounds" and those required for protection and insulation resistance. Use testing instruments (i.e., megger). Activation of each circuit will be required as final test. Testing shall be done at no additional expense to the Owner.
- C. Documents: Drawings are indicative of Work to be installed but do not indicate all bends, fittings, boxes, etc. that will be required in this Contract. The structural and finished conditions of the Project shall be investigated prior to construction.
- D. Coordination: Coordinate Work with other trades to avoid interference between piping, ducts, equipment, architectural or structural features. In case of interference, the Engineer shall determine which work is to be relocated, regardless of which was first installed.
- E. Equipment Pads: All equipment pads located in areas receiving a floor finish (i.e., tile, paint) shall be painted. Type of paint shall be approved for concrete application. Color shall be as selected by the Engineer.
- F. Quality: All electrical equipment or apparatus of any one system shall be of the same quality as produced by one or more manufacturers, suitable for use in a unified system. The term "manufacturer" shall be understood as applying to a reputable firm who assumes full responsibility for its products.
- G. Products: When more than one name of manufacturer is listed in the Division 26 and other division Specifications, the first manufacturer and catalogue number determine the style and quality. Other manufacturers named have been included based on their ability to furnish (fabricate, construct and

test) equipment that will provide similar quality and performance. Products from these “other” manufacturers will be reviewed by the Engineer providing the physical and performance attributes provide equivalence to those of the first named manufacturers. The Engineer shall provide sole determination to this equivalency. If such products are acceptable to the Engineer but differ from those named in the Specification or on the Drawings to the extent that their proper incorporation into the Work requires changes to the structural piping, mechanical, electrical, instrumentation, or any other changes of whatsoever nature, the Contractor shall be responsible for such changes. See Part 1 “Submittals” and “Substitutions” specified elsewhere for additional requirements.

1.6 REGULATIONS

- A. All regulations (e.g., federal and state laws, municipal/local ordinances, codes and industry standards adopted by the authority having jurisdiction) bearing on the conduct of the Work or referenced by these Contract Documents are hereby incorporated and made a part of these specifications. Each entity engaged in construction on the Project shall be familiar with the regulations applicable to its construction activity. Where copies of the regulations are needed to perform a required construction activity, the Contractor shall obtain copies directly from the publication source. Regulations applicable to this Project but are not limited to the following:
 1. Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities (ADAAG).
 2. International Code Council (ICC) Codes (i.e. International Building Code - IBC, International Electrical Code - IEC, International Energy Conservation Code - IECC, International Fire Code - IFC, International Mechanical Code - IMC, International Fuel Gas Code - IFGC, etc.)
 3. Pennsylvania Department of Environmental Protection (PA DEP) (i.e. Administration of the Storage Tank and Spill Prevention Program; etc.)
 4. Pennsylvania Department of Labor and Industry (PA L&I) (i.e. Building Energy Conservation Standards; Uniform Construction Code; Lighting; etc.)
 5. National Fire Protection Association (NFPA) (i.e. NFPA 70 “National Electric Code”, NFPA 90A “Installation of Air-Conditioning and Ventilating Systems”, NFPA 101 “Life Safety Code”, etc.)
 6. National Electrical Safety Code - ANSI C2.
 7. Owner's Insuring Agency.
- B. Should any change in the drawings and/or specifications be required to conform to the codes, ordinances, regulations or laws mentioned above, the Engineer shall be notified prior to the time of submitting bids. After signing of the Contract, each Contractor will be responsible for the completion of all work necessary to meet the above-written requirements without additional expense to the Owner.
- C. The Contractor shall comply with all rules, regulations and recommendations of any public utility serving this Project.
- D. The entire electrical system shall be installed in accordance with the latest edition of the National Electrical Code, approved by the governmental body having jurisdiction, including amendments thereto.
- E. All electrical equipment and its components and materials shall meet all applicable UL criteria and bear the appropriate label of the Underwriters' Laboratory. All control panels, motor controller sections, etc. shall bear the UL-508A listing. All complete assemblies shall be UL listed.
- F. The electrical Work on this Project shall be inspected by local AHJ. The Contractor shall pay for all costs relative to the inspections. Any work failing to pass inspection shall be corrected and re-inspected at no additional cost to the Owner. Final wiring certificates shall be in triplicate and shall be delivered to the Engineer for review. The Contractor shall formally file for this inspection within twenty (20) days of signing the Contract.

1.7 DRAWINGS AND SPECIFICATIONS

- A. The drawings are generally diagrammatic and indicative of the Work to be installed. Exact locations of equipment and points of termination shall be reviewed with the Engineer. Should it be found that any system or equipment cannot be installed as shown on the drawings; the Engineer shall be consulted before installing or making changes to the layout.
- B. The drawings and specifications are intended to function as a common set of documents. Anything shown on the drawings but not in the specifications, or mentioned in the specifications and not shown on the drawings, shall be equally binding as if both noted on the drawings and called for in the specifications.
- C. No measurement of a drawing by scale shall be used as a working dimension. Working measurements shall be taken from figured dimensions and through cooperation with all other Subcontractors.
- D. This Contractor shall carefully examine all Project Contract Drawings and Specifications (electrical and non-electrical). If any discrepancies occur between the drawings or between the drawings and specifications, the discrepancies shall be reported to the Engineer in writing and obtain written instructions as to the manner in which to proceed. No departures from the Contract Drawings shall be made without prior written instructions from the Engineer. Where conflicts exist between drawings, specifications, and equipment schedules, the most stringent shall apply.
- E. All items of labor, material and equipment not specified in detail or shown on the drawings but incidental to or necessary for the complete and proper installation and proper operation of the several branches of the Work described herein or reasonably implied in connection therewith, shall be furnished as if called for in detail by the specifications or drawings.

1.8 FAMILIARITY WITH CONTRACT REQUIREMENTS

- A. It is the responsibility of the Contractor, prior to submitting a bid on this Project, to satisfy himself as to the nature and location of the work, the conformation of the ground, soil characteristics, the character, quality and quantity of the materials which will be required, the character of equipment and facilities needed preliminary to and during the prosecution of the work, the general and local conditions, and of all other matters which can in any way affect the work under this Contract.
- B. Failure to make an on-site inspection prior to submitting a bid, or failure to comply with any or all of the above requirements will not relieve this Contractor from the responsibilities of properly estimating the requirements or costs of successful completion of the work nor from the responsibility for the faithful performance of the provisions of this Contract.
- C. The Electrical Contractor shall confer with all other sub-contractors and shall apply for detailed and specific information regarding the location of all equipment as the final location may differ from that indicated on the drawings. Outlets, equipment or wiring improperly placed because of the Electrical Contractor's failure to obtain this information shall be relocated and reinstalled by the Electrical Contractor without additional expense to the Owner.

1.9 SUBMITTALS

- A. General: Follow the procedures as defined by Part 1 paragraph "Related Documents" Division 01 "Submittals" and as indicated below:
 - 1. Collect Product Data into a single submittal for each element of construction or system. Product Data includes printed information, such as manufacturer's installation instructions, catalog cuts, standard color charts, roughing-in diagrams and templates, standard wiring diagrams, and performance curves.

- a. Mark each copy to show applicable choices and options. Where printed Product Data includes information on several products that are not required, mark copies to indicate the applicable information using arrows and/or highlighting on all copies. Include the following information:
 - 1) Manufacturer's printed recommendations.
 - 2) Compliance with trade association standards.
 - 3) Compliance with recognized testing agency standards, especially UL.
 - 4) Application of testing agency labels and seals.
 - 5) Notation of dimensions verified by field measurement.
 - 6) Notation of coordination requirements.
 - 7) Manufacturer's clearance requirements for operation, maintenance and replacement of operating equipment devices.
 - 8) Compliance with all pertinent specification and drawing requirements shall be indicated on the manufacturer's drawings.
2. Engineer's Action Stamp: Each submittal will be marked and stamped by the Engineer to indicate the appropriate action to be taken by the Contractor. Appropriate action will be as follows:
 - a. Final Unrestricted Release: When the Engineer marks a submittal "No Exceptions Taken," the Work covered by the submittal may proceed provided it complies with requirements of the Contract Documents.
 - b. Final-But-Restricted Release: When the Engineer marks a submittal "Make Corrections Noted, Resubmittal Not Required," the Work covered by the submittal may proceed provided it complies with notations or corrections on the submittal and requirements of the Contract Documents.
 - c. Returned for Resubmittal: When the Engineer marks a submittal "Make Corrections Noted and Resubmit," do not proceed with Work covered by the submittal, including purchasing, fabrication, delivery, or other activity. Revise or prepare a new submittal according to the notations; resubmit without delay. Repeat if necessary to obtain different action mark.
 - 1) The entire submittal shall be corrected and resubmitted for review. Incomplete resubmissions will be returned to the Contractor for the inclusion of missing items and/or information. A resubmission will be considered incomplete when items and/or information submitted previously are not included in the resubmittal regardless of whether the items and/or information were required to be revised/corrected or not.
 - 2) Do not use, or allow others to use, submittals marked "Make Corrections Noted and Resubmit " at the Project Site or elsewhere where Work is in progress.
 - d. Not Permitted to be Used: When the Engineer marks a submittal "Rejected," do not proceed with Work covered by the submittal. Do not resubmit the same manufacturer or type of material, depending upon comments by the Engineer. Prepare a new submittal according to the notations; resubmit without delay. Repeat if necessary to obtain different action mark.
 - 1) The entire submittal shall be resubmitted for review. Incomplete resubmissions will be returned to the Contractor for the inclusion of missing items and/or information.
 - 2) Do not use, or allow others to use, submittals marked "Rejected - See Remarks" at the Project Site or elsewhere where Work is in progress.
 - e. Other Action: Where a submittal is for information or record purposes or special processing or other activity, the Engineer will return the submittal marked "Review Not Required."
3. Sample Submittals: Refer to individual Specification Sections for requirements for Samples that illustrate workmanship, fabrication techniques, details of assembly, connections, operation, and similar construction characteristics.
 - a. Color Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.
 - b. Number of Samples: Submit one (1) complete set of sample products that are proposed to be installed in the Project.

- c. Review of Samples: A transmittal letter verifying receipt of the submitted samples will be returned to the Contractor indicating the action taken by the Engineer. At the discretion of the Engineer, the samples may or may not be returned with the transmittal letter to the Contractor. If samples are returned, the submitted samples are not guaranteed to be in useable condition and suitable for installation in the Project.
 - d. Ownership of Samples: All submitted samples not returned to the Contractor shall become the property of the Engineer and may be disposed of at the Engineer's discretion. Samples returned to the Contractor and not indicated as the property of the Owner shall become the property of the Contractor.
 - e. Return Policy: Contractor may request the submitted samples be returned within ten (10) days after receiving the above indicated transmittal letter. If acceptable to the Engineer, the Contractor will be responsible for retrieving the samples from the Engineer's office during regular office hours. After the Contractor has notified the Engineer of his request to retrieve the submitted samples, the Contractor shall have 10 days to remove the samples from the Engineer's office. (Samples will not be mailed.) All samples not removed within the allotted time shall become the property of the Engineer and may be disposed of at the Engineer's discretion.
 - f. Installation of Samples: Submitted samples may be incorporated into the Work but such samples shall be in an undamaged condition at time of use and/or installation.
4. Unsolicited Submittals: A transmittal letter verifying receipt of the unsolicited submittal (which may include samples) will be marked "Review Not Required" and returned to the Contractor. The Engineer may or may not return unsolicited submittals and associated samples with the transmittal letter to the Contractor at the Engineer's discretion. See "Sample Submittals" paragraph above for return policy.
- B. The submissions are the Contractor's documents, and the Engineer's approval constitutes an acknowledgment that the documents have been submitted and nothing more. It is the Contractor's responsibility to check his/her own submissions for compliance with Contract Documents and the Project conditions.
- C. If the Contractor submits a product of a manufacturer which appears as a second or third name without corresponding catalogue numbers and/or the manufacturer is not listed by name, the submittal shall include a Compliance Report. See "Substitutions" article specified elsewhere in Part 1 for Compliance Report requirements and additional substitution requirements.
- D. This Contractor shall submit to the Engineer copies of shop drawings, catalogue cuts, data sheets, etc. of all equipment and materials as called for herein. Shop drawings shall be corrected as directed by the Engineer and resubmitted until satisfactory. No work shown on any shop drawing shall be executed until such shop drawings are reviewed.
- E. All drawings, etc., submitted for approval shall be marked with the Name of the Project and shall bear the stamp of approval of the Contractor as evidence that the material has been checked by the Contractor. Any drawings, etc., submitted without this stamp of approval will not be considered and will be returned to the Contractor for resubmission.
- F. Additional copies may be required by individual sections of these Specifications.
- G. The Engineer, Owner, and the authority having jurisdiction (AHJ) reserve the right to request additional shop drawings and product data to clarify previously submitted material.
- H. No appurtenances shall be installed in the Work or orders placed for same until product data and shop drawing approval has been given by the Engineer. See "Division 26 and other Division Submittals Chart" at the end of this Section for required submissions.

1.10 SUBSTITUTIONS

- A. General: In order to establish standards of quality and performance, all types of materials listed hereinafter by manufacturer's names and/or manufacturer's catalogue number shall be provided as specified. Unless specifically stated otherwise, or separately priced in Division 01 or Division 26 and other Division Sections "Alternate Bids", the Contractor shall provide the materials or products as specified. If this Contractor desires to substitute an item, he/she shall comply with the following administrative and procedural requirements that are included in this Section to expand the requirements as defined by Part 1 paragraph "Related Documents".
- B. Substitutions will be permitted only on products specified with the phrase "or approved equal", "or as approved", "or equal", "or equivalent", etc. and the burden shall be upon the bidder to prove such equality. If the Contractor elects to prove such equality, he/she must request the Engineer's approval in writing to substitute such item for the specified item, and shall submit supporting data, and samples if required, to permit a fair evaluation of the proposed substitution with respect to quality, serviceability and warranty.
- C. When the phrase "or approved equal", "or as approved", "or equal", "or equivalent", etc. appears and the Contractor desires to furnish equipment of a manufacturer other than that specified or intended, he/she shall include a complete specification of the substituted item, along with each submission copy of shop drawings, indicating the necessary modifications to the substituted product to satisfy the requirements of the Contract Documents.
 - 1. Compliance Report: Along with each submission copy of the product data and/or shop drawing, the manufacturer shall indicate the necessary modifications to the product and/or system to satisfy the requirements of the Contract Documents. Each paragraph including all subparagraphs shall bear the same paragraph number as the contract specification so that a close comparison can be made to the manufacturer specified herein by catalog number(s).
 - a. Each paragraph for the substituted product/system shall be identified as follows:
 - 1) Comply: The term "comply" shall only be used when the product/system indicated by the paragraph is completely equal in all respects to the type of material used, functionality, programmability, size, accessories to be provided, future capabilities, mounting, etc. to that which was specified. Anything less is not to be considered as complying and shall not be indicated as "Comply".
 - 2) Exception: The term "exception" shall be used when the product/system indicated by the paragraph does not meet the definition of "comply" as indicated above. The manufacturer shall provide a brief, clear and non-technical description of why the product/system does not meet the requirements of the specification and why it is not necessary to provide the specified materials, components, features, etc.
 - 3) Deviate: The term "deviate" shall be used when the product/system indicated in the paragraph does not fully comply but the manufacturer is willing to provide all the necessary materials, components, features, accessories, future capabilities, etc. to meet the intent of the Contract Documents as determined by the Engineer. The manufacturer shall provide a brief, clear and non-technical description of what additional items are to be provided and how these items affect the product/system.
 - b. Compliance report may be submitted prior to the submission of the substituted product data and/or shop drawings but the Engineer reserves the right to request that certain product data, shop drawings, wiring diagrams, certificates, etc. be included as requested.
 - 2. All costs involved in changes in the building, to the equipment, to the arrangement of equipment, or to the Work performed or to be performed under other sections of the specifications, due to the substitution of equipment in lieu of that shown on the drawings or specified, shall be borne by the Contractor making such substitutions, and shall include, but not necessarily be limited to,

costs or fees in connection with resubmission of drawings for approval, if required, by the State, local authorities or insuring agencies having jurisdiction over the Work.

1.11 ELECTRONIC DRAWINGS

- A. CAD Files: If the Contractor wishes to purchase the Engineer's CAD files to prepare a submittal, drawings in electronic format will be distributed in accordance with the following procedures:
 1. Contractor shall submit a written request to the Engineer indicating the sheet numbers to be provided in electronic format for his/her use.
 2. A basic service fee of \$50 will be charged to the Contractor for each drawing requested. This fee must be paid by the Contractor prior to delivery of the electronic files and/or media. Full set of drawings might be purchased at a fixed fee if desired by Contractor. Coordinate with Engineer during construction.
 3. Drawings
 - a. Binding and Purging: Upon receipt of payment for the electronic files, the drawings will be bound and purged of all legal and proprietary information not relevant to the Contractor's requested use. This legal information may include, but may not be limited to, the professional seal(s), trademark(s), border(s), engineering calculation(s), etc.
 - b. Format: Drawings will be formatted for use with Autodesk's AutoCAD (2016). The Contractor shall be responsible for making sure that his/her hardware/software is compatible with the electronic files. The Engineer will not be responsible for providing the necessary hardware/software to the view and/or use the electronic files.
 - c. Electronic Media Disclaimer Note: Each drawing will include the following Electronic Media Disclaimer Note or something similar:
 - 1) Although Buchart Horn transmits this electronic media for your assistance, it remains the sole property of the Buchart Horn. Buchart Horn reserves the right to modify or reclaim this information at our discretion. The Recipient assumes responsibility for use of this electronic media and for coordination of any updated or additional information and/or data. Buchart Horn is not responsible to the Recipient (or any other Users allowed to use this electronic media by the Recipient) for compatibility with the Recipient's hardware and/or software. The Recipient shall scan this electronic media for virus contamination prior to its use.
 - 2) Unauthorized reproduction or distribution of this electronic media, or any portion thereof, may result in severe civil and criminal penalties, and will be prosecuted to the maximum extent possible under the law.
 - 3) By using the data contained in this electronic file, the Recipient indicates that he/she has read this Electronic Media Disclaimer Note and agrees to the above terms and conditions for the use of this electronic media."
 4. Conditions of Use
 - a. Changes to Bid Documents: The requested electronic file(s) may or may not incorporate all changes to the Contract Documents that have been issued as addenda, bulletins, change orders, clarifications, etc. The Contractor shall be responsible for including all such changes not incorporated in the electronic file(s).
 - b. Verification: Contractor shall verify that the requested electronic file(s) are identical to the Contract Documents less items issued as addenda, bulletins, change orders, clarifications, etc. If discrepancies are found between the electronic file(s) and the Contract Documents, the Contractor shall notify the Engineer immediately so that the electronic file(s) can be corrected/updated and forwarded to the Contractor in a timely manner.
 - c. No Discrepancies: If there are no discrepancies between the electronic file(s) and the Contractor's Contract Documents less the items indicated above, the Contractor shall provide a letter to the Engineer indicating that the electronic file(s) are acceptable.

- d. Notification: If the Contractor does not notify the Engineer within seven (7) days after receipt of the file(s) as to whether or not the file(s) are acceptable, the Engineer will assume that the file(s) have been accepted by the Contractor and any request for additional file(s) after this period of time will be considered as separate purchase request.
5. Indemnification: The Contractor shall hold harmless the Engineer against all damages, liabilities or costs, including legal fees and defense costs, arising from the use of these electronic file(s).
6. Interpretation: The Engineer is the sole interpreter of these electronic file(s). By use the electronic file(s), the Contractor shall not be relieved of his/her duty to fully comply with the Contract Documents, including, but not limited to, the need to check, confirm, and coordinate the Contractor's Work with that of other Contractors for the Project.

1.12 QUALITY ASSURANCE

- A. General: All work whether it be architectural, structural, mechanical, or electrical in nature shall be installed in a first class, neat and workmanlike manner by mechanics skilled in the trade involved.
- B. Quality of Workmanship: Electrical appurtenances shall be installed in a neat and workmanlike manner as required by the National Electrical Code Article 110.12. and shall be in compliance with NECA 1-2010 "Standard Practices for Good Workmanship in Electrical Contracting" as a minimum. See other Division 26 and other Division specification sections for more stringent requirements.
- C. Final Approval: The quality of workmanship shall be subject to the approval of the Engineer. Any work found by the Engineer to be of inferior quality and/or workmanship shall be replaced and/or reworked until approval of the Engineer is obtained.
- D. Cost: Any cost involved in obtaining said approval shall be the responsibility of the Electrical Contractor.

1.13 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect and handle products in accordance with the requirements as defined by Part 1 paragraph "Related Documents".
- B. Properly identify products with names, model numbers, types, grades, compliance labels, and other information needed for identification.
- C. Protect all unfinished installations, construction materials and equipment to the satisfaction of the Engineer and the Owner.

1.14 EXTRA MATERIALS

- A. General: The extra materials specified in this Article shall be in addition to those extra materials specified in other Division 26 and other Division Sections. Contractor shall include in his bid all costs associated with furnishing and installing the indicated extra material.

PART 2 PRODUCTS (ADMINISTRATIVE SUBMITTALS)

2.1 GENERAL

- A. Prepare electrical administrative submittals in accordance with the requirements as defined by Part 1 paragraph "Related Documents". In addition to the requirements referenced in the "Related Documents" paragraph and Division 01, prepare these administrative submittals to meet the minimum requirements as specified herein.

2.2 SCHEDULE OF VALUES (DETAILED BREAKDOWN)

- A. A Schedule of Values (Detailed Breakdown) for the Electrical Work of this Project shall be prepared by the Contractor using forms provided by the Engineer. Where a Schedule of Values is not required by the Division 01 Specification Sections, the Contractor shall request a sample form from the Engineer.
- B. The Schedule of Values shall have a level of detail equal to or greater than the example form provided by the Engineer or Engineer and as indicated below:
 - 1. General: Use the Project Manual table of contents as a guide to establish line items for the Schedule of Values. Provide at least one line item for each electrical Specification Section and as indicated below:
 - a. Bond and insurance.
 - b. Mobilization and supervision.
 - c. Inspection.
 - d. Temporary electric.
 - e. Demolition and cleanup.
 - f. Removal and Disposal of Hazardous/Contaminated Material: Provide breakdown for each type of material disposed of.
 - g. Record documents and operation and maintenance manuals.
 - h. Utility Charges.
 - 1) Power.
 - i. Excavation and backfill.
 - j. Ductbank and Concrete encasement.
 - k. Conductors: 120V to 15kV.
 - 1) #12 to #8 wire.
 - 2) #6 to #1 wire.
 - 3) #1/0 to #4/0.
 - 4) 250 kcmil to 1000 kcmil.
 - l. Cables: Provide breakdown for each type specified.
 - m. Surface Raceway: Metal and plastic.
 - n. Conduit: Metallic and PVC.
 - 1) ¾" to 1".
 - 2) 1 ¼" to 2".
 - 3) 2 ½" to 3".
 - 4) 3 ½" to 4".
 - 5) 5".
 - o. Engine Generators.
 - 1) Generator set.
 - 2) Generator Control System.
 - p. Distribution Equipment.
 - 1) Panelboards.
 - 2) Surge suppression.
 - 3) Disconnect switches.
 - 4) Circuit breakers.
 - 5) Enclosed controllers.
 - q. Coordination Drawings.
 - 1) Switchgear Building with Switchgear and other supporting systems.
 - r. Identification: Include the following Project identification on the Detailed Breakdown:
 - 1) Project name and location.
 - 2) Name of Engineer.
 - 3) Engineer's project number.

- 4) Contractor's name and address.
- 5) Contractor's trade for which the Contract was awarded.
- 6) Date of submittal.
- 7) Contract price.
- s. Table Format: Include the following columns in the Schedule of Values (Detailed Breakdown):
 - 1) Item No. and Description of Item.
 - 2) Number & Kind of Units.
 - 3) Cost per Unit.
 - 4) Division of Unit: Breakout the following into separate columns:
 - (a) Material.
 - (b) Labor.
 - 5) Total Amount.
- t. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment, progress reports, Change Orders (debit/credit), Work Orders (time and material), etc.
 - 1) Percentage of the Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent.
 - 2) Round amounts to nearest whole dollar; total shall equal the Contract Sum.
- C. The Contractor shall submit the Schedule of Values (Detailed Breakdown) for review as a shop drawing at the earliest possible date prior to all other shop drawings and/or product data and before proceeding with any Work.

2.3 **RECORD DOCUMENTS**

- A. Mark-up Procedure: During construction, maintain a set of blue- or black-line white prints of Contract Drawings and Shop Drawings for Project Record Document purposes.
 1. Mark these Drawings to show the actual installation where the installation varies from the installation shown originally. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later. Items required to be marked include, but are not limited to, the following:
 - a. Revisions to details shown on the Drawings.
 - b. Locations and depths of all underground utilities and underslab conduits.
 - c. Locations of interior conduits larger than 2" diameter not installed underslab.
 - d. Locations of all feeder conduits.
 - e. Revisions to Branch and Feeder Circuits: Record circuit numbers and associated panelboard space numbers for all existing, new, or relocated electrical appurtenances, mechanical equipment, owner furnished equipment, etc. that required power or reconnection of existing electrical services. Each circuit number shall be shown with a homerun coming off the equipment it serves. Circuit numbers indicated on the record drawings shall match the new or updated panelboard indexes.
 - f. Actual installed equipment locations.
 - g. Changes made by change order, Engineer's written orders, and Owner requested.
 - h. Mark record sets with red erasable colored pencil. Use other colors to distinguish between changes for different categories of the Work at the same location.
 - i. Mark important additional information that was either shown schematically or omitted from original Drawings.
 - j. Note Construction alternate numbers, change-order numbers, and similar identification.
 - k. Accurately record information in an understandable drawing technique.
 - l. Record data as soon as possible after obtaining it. Record and check the mark-up prior to enclosing concealed installations.

- m. At time of Substantial Completion, submit record drawings to the Engineer for the Owner's records. Organize into sets and bind and label sets for the Owner's continued use.
- B. Format: Record drawings shall be made complete including all changes and additional information that were recorded. Final record drawings may be provided at time of Substantial Completion in either hard copy format or in electronic media format as follows:
 - 1. Copies
 - a. Hard Copy: Print/copy a minimum of two (2) black-line prints of each record drawing as referenced in the general provisions of the Contract by the "Related Documents" paragraph and as directed by the Engineer. Organize the copies into manageable sets. Bind each set with durable-paper cover sheets. Include appropriate identification, including titles, dates, and other information on the cover sheets.
 - b. Electronic Media: Provide record drawings in electronic format on compact disk(s) in Autodesk's AutoCAD 2008 for Windows reflecting the set of blue- or black-line prints. Label CD and CD case with appropriate identification, including titles, dates, and other information which may appear on the project prints.
 - 2. Distribution
 - a. Organize and bind original marked-up set of prints that were maintained during the construction period into manageable sets. Bind and date marked-up set. Provide protective covering to prevent moisture, dirt, and other debris from deteriorating marked-up set of prints. Protective covering shall include appropriate identification, including project title and date.
 - b. Submit the original marked-up record set(s) and hard copy sets or electronic media to the Engineer for the Owner's records.

2.4 OPERATION AND MAINTENANCE MANUALS

- A. Form of Submittal: In addition to these requirements, coordinate organization and submission with the requirements of Division 1. Prepare operation and maintenance manuals in the form of an instructional manual for use by the Owner's operating personnel. Organize into suitable sets of manageable size. Where possible, assemble instructions for similar equipment into a single binder.
 - 1. Binders: For each manual, provide heavy-duty, commercial-quality, 3-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to receive 8-1/2-by-11-inch paper. Provide a clear plastic sleeve on the spine to hold labels describing contents. Provide pockets in the covers to receive folded sheets.
 - a. Where two (2) or more binders are necessary to accommodate data, correlate data in each binder into related groupings according to the Project Manual table of contents. Cross-reference other binders where necessary to provide essential information for proper operation or maintenance of the piece of equipment or system.
 - b. Identify each binder on front and spine, with the printed title "ELECTRICAL OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter covered. Indicate volume number for multiple volume sets of manuals.
 - 2. Dividers: Provide heavy paper dividers with celluloid-covered tabs for each separate Section. Mark each tab to indicate contents. Provide a typed description of the product and major parts of equipment included in the Section on each divider.
 - 3. Protective Plastic Jackets: Provide protective, transparent, plastic jackets designed to enclose diagnostic software for computerized electronic equipment.
 - 4. Text Material: Where maintenance manuals require written material, use the manufacturer's standard printed material. If manufacturer's standard printed material is not available, provide specially prepared data, neatly typewritten, on 8-1/2-by-11-inch, 20-lb/sq. ft. white bond paper.
 - 5. Drawings: Where maintenance manuals require drawings or diagrams, provide reinforced, punched binder tabs on drawings and bind in with text.

- a. Where oversize drawings are necessary, fold drawings to the same size as text pages and use as a foldout.
 - b. If drawings are too large to be used practically as a foldout, place the drawing, neatly folded, in front or rear pocket of binder. Insert a typewritten page indicating drawing title, description of contents, and drawing location at the appropriate location in the manual.
- B. Manual Content
 1. In each manual include information specified in the individual Specification Section and the following information for each major component of building equipment and its controls:
 - a. General system or equipment description.
 - b. Design factors and assumptions.
 - c. Copies of all approved Shop Drawings and Product Data including products/systems installed during construction by change order, etc.
 - d. System or equipment identification, including:
 - 1) Name of manufacturer.
 - 2) Model number.
 - 3) Serial number of each component.
 - e. Operating instructions.
 - f. Emergency instructions.
 - g. Wiring diagrams.
 - h. Inspection and test procedures.
 - i. Inspection reports and certificates.
 - j. Maintenance procedures and schedules.
 - k. Precautions against improper use and maintenance.
 - l. Copies of warranties.
 - m. Repair instructions including spare parts listing.
 - n. Sources of required maintenance materials and related services.
 - o. Manual index.
 - p. Training documentation and DVD of training.
 2. Organize each manual into separate Sections for each piece of related equipment. As a minimum, each manual shall contain a title page; a table of contents; copies of Product Data, supplemented by Drawings and written text; and copies of each warranty, bond, and service contract issued.
 - a. Title Page: Provide a title page in a transparent, plastic envelope as the first sheet of each manual. Provide the following information:
 - 1) Subject matter covered by the manual.
 - 2) Name and address of the Project.
 - 3) Date of submittal.
 - 4) Name, address, and telephone number of the Contractor.
 - 5) Name and address of the Engineer.
 - 6) Cross-reference to related systems in other operation and maintenance manuals.
 - b. Table of Contents: After title page, include a typewritten table of contents for each volume, arranged systematically according to the Project Manual format. Include a list of each product included, identified by product name or other appropriate identifying symbol and indexed to the content of the volume.
 - 1) Where a system requires more than one volume to accommodate data, provide a comprehensive table of contents for all volumes in each volume of the set.
 - c. General Information: Provide a general information Section immediately following table of contents, listing each product included in the manual, identified by product name. Under each product, list the name, address, and telephone number of the Subcontractor or Manufacturer and the maintenance contractor. Clearly delineate the extent of responsibility of each of these entities. Include a local source for replacement parts and equipment.

- d. Product Data: Where the manuals include manufacturer's standard printed data, include only sheets that are pertinent to the part or product installed. Mark each sheet to identify each part or product included in the installation. Where the Project includes more than one item in a tabular format, identify each item, using appropriate references from the Contract Documents. Identify data that is applicable to the installation, and delete references to information that is not applicable.
 - e. Written Text: Prepare written text to provide necessary information where manufacturer's standard printed data is not available, and the information is necessary for proper operation and maintenance of equipment or systems. Prepare written text where it is necessary to provide additional information or to supplement data included in the manual. Organize text in a consistent format under separate headings for different procedures. Where necessary, provide a logical sequence of instruction for each operation or maintenance procedure.
 - f. Drawings: Provide specially prepared drawings where necessary to supplement manufacturer's printed data to illustrate the relationship of component parts of equipment or systems or to provide control or flow diagrams. Coordinate these drawings with information contained in project record drawings to assure correct illustration of the completed installation.
 - 1) Do not use original project record documents as part of operation and maintenance manuals.
 - g. Warranties, Bonds, and Service Contracts: Provide a copy of each warranty, bond, or service contract in the appropriate manual for the information of the Owner's operating personnel. Provide written data outlining procedures to follow in the event of product failure. List circumstances and conditions that would affect validity of warranty or bond.
 - h. Approval letters from the following:
 - 1) Local authority having jurisdiction.
 - 2) Inspection agency.
 - 3) Field representative for specific systems, i.e. fire alarm, signal/communication, intrusion detection, etc.
- C. Electrical Maintenance Manual
1. Equipment and Systems: Provide the following information for each piece of equipment, each building operating system, and each electric or electronic system.
 - a. Description: Provide a complete description of each unit and related component parts, including the following:
 - 1) Equipment or system function.
 - 2) Operating characteristics.
 - 3) Limiting conditions.
 - 4) Performance curves.
 - 5) Engineering data and tests.
 - 6) Complete nomenclature and number of replacement parts.
 - b. Manufacturer's Information: For each manufacturer of a component part or piece of equipment, provide the following:
 - 1) Printed operation and maintenance instructions.
 - 2) Assembly drawings and diagrams required for maintenance.
 - 3) List of items recommended to be stocked as spare parts.
 - c. Maintenance Procedures: Provide information detailing essential maintenance procedures, including the following:
 - 1) Routine operations.
 - 2) Troubleshooting guide.
 - 3) Disassembly, repair, and reassembly.
 - 4) Alignment, adjusting, and checking.

- d. Operating Procedures: Provide information on equipment and system operating procedures, including the following:
 - 1) Startup procedures.
 - 2) Equipment or system break-in.
 - 3) Routine and normal operating instructions.
 - 4) Regulation and control procedures.
 - 5) Instructions on stopping.
 - 6) Shutdown and emergency instructions.
 - 7) Summer and winter operating instructions.
 - 8) Required sequences for electric or electronic systems.
 - 9) Special operating instructions.
 - 10) Video training sessions with Owner.
 - e. Servicing Schedule: Provide a schedule of routine servicing and lubrication requirements, including a list of required lubricants for equipment with moving parts.
 - f. Controls: Provide a description of the sequence of operation and as-installed control diagrams by the control manufacturer for systems requiring controls.
 - g. Circuit Directories: For electric and electronic systems, provide complete circuit directories of panelboards, including the following:
 - 1) Electric service.
 - 2) Controls.
 - 3) Communication.
- D. The Contractor shall submit to the Engineer copies of the maintenance manual(s) for review and approval. Maintenance manuals shall be corrected as directed by the Engineer and resubmitted until satisfactory.
- 1. In addition to the number of maintenance manuals referenced in the "Related Documents" paragraph, prepare one (1) additional copy in PDF format to be kept by the Engineer.
- E. Format: Maintenance manuals shall be made complete including all changes and additional information that were recorded. Prepare manuals at time of Substantial Completion as follows:
- 1. Copies
 - a. Prints/Copies: Print/copy a minimum of two (2) sets of maintenance manuals as referenced in the general provisions by the "Related Documents" paragraph and as directed by the Engineer. Organize the manuals into manageable sets (volumes).
 - b. Electronic Media: Provide maintenance manual(s) in electronic format on compact disk(s) in latest version of Adobe Acrobat reflecting the set of maintenance manuals. Label CD and CD case with appropriate identification, including titles, dates, and other information which may appear on the binder of the maintenance manual and/or the manual's table of contents.
 - 2. Distribution
 - a. If a set of maintenance manuals includes more than one binder (volume), each set of manuals shall be packaged separately.
 - b. Submit the sets of maintenance manuals and electronic media to the Engineer for review and approval. Maintenance manuals shall be corrected as directed by the Engineer and resubmitted until satisfactory.
 - c. Final sets of maintenance manuals and electronic media shall be turned over to the Engineer for the Owner's records. In addition to the number of maintenance manuals referenced in the "Related Documents" paragraph, prepare one (1) additional copy including the electronic media to be kept by the Engineer.

PART 3 EXECUTION**3.1 GENERAL REQUIREMENTS**

- A. This Contractor shall expedite the work for a specific area, section or part of the Project to make provision for, or protect equipment or to permit the installation of another part of the work.
- B. All materials and equipment supplied by this Contractor shall be new, of the best of their respective kinds, without imperfections and blemishes, and shall be protected from the elements prior to installation.
- C. Protect all equipment during construction. All equipment damaged as a result of not properly protecting said equipment shall be repaired at no cost and to the satisfaction of the Engineer and Owner.
- D. All conduits, wire, cable, wiring devices and equipment shall be installed in such a manner as to preserve access to any existing equipment or to any new equipment installed under this specification or under other specifications or contracts for this Project and with sufficient space provided for proper operation and maintenance.
- E. The drawings are generally indicative of the work to be installed but do not indicate all bends, fittings, boxes, etc., which may be required. The Contractor shall carefully investigate the structural and furnish conditions affecting his work, arrange his Work accordingly, and furnish such fittings as may be required to meet such conditions.
 - 1. The schematic or layout wiring as shown on the drawings shall not be considered as absolute; it shall be subject to changes where necessary to overcome obstacles in construction.
 - 2. Where a major deviation from the plans is indicated by practical consideration, shop drawings shall be submitted showing all deviations in detail to clearly indicate the necessity or desirability for the change.
- F. This Contractor shall coordinate his Work with other trades so that all work may be installed in the most direct manner and so that interference between piping, ducts, equipment, and Architectural or structural features will be avoided. In cases of interference, conflicts, or fouling results, the Engineer shall decide which work is to be relocated, regardless of which was installed first. Such relocation shall be at no additional expense to the Owner.
- G. All materials and equipment installed by the Contractor shall be firmly supported and secured to the building structure/construction as required.
 - 1. Furnish and install all necessary steel angles, beams, channels, hanger rods or other supports for equipment and piping furnished under this Contract requiring support or suspension from building structure, except support steel where otherwise noted on the plans.
- H. Scaffolding with ladders shall be furnished and erected, where required for the proper installation of wiring, equipment and fixtures.

3.2 SCHEDULING

- A. Construction Schedule:
 - 1. Time is of the essence. The Contractor shall immediately procure all long lead equipment items with the associated equipment manufacturer/distributor of the equipment to trigger the submittal process as defined for each equipment item as listed in its respective technical specification. The Contractor is solely responsible for the management of the effort to meet the time requirements of the contract as defined in the Contract Documents and Division 1.

2. The Contractor shall develop and maintain a construction schedule for all major tasks associated with the project. In addition, milestone dates shall be included to document major equipment approvals, release to manufacture, anticipated delivery dates, anticipated mobilization to site, startup and testing of major equipment, substantial completion, close out and demobilization. These key milestone dates are identified in the Contract Provisions of the Project Manual. The Contractor shall provide updates to the construction schedule as requested by Engineer/Owner and prior to scheduled construction progress meetings.
3. The construction schedule shall utilize construction oriented project scheduling software (Suretrak, Primavera, or Equal) and shall utilize the initial construction schedule as submitted and approved with critical path activities within 60 days of notice to proceed. All progress updates shall reflect true reality of the actual progress of construction showing lead and lag time durations and associated with each task. For scheduled items delaying the anticipated critical path of the schedule, the Contractor shall narratively describe in explicit detail remediation of the particular items associated with delaying the critical path to bring the project back into the contract defined duration. The details associated with the task remediation will be discussed in detail with the Engineer and Owner for acceptance of resolving the particular issue. If an issue cannot be resolved or agreed upon with the Owner\Engineer, the Contractor shall submit a detailed contingency plan in conjunction with the discussed task or with 3 days of a meeting with the Owner/Engineer.

3.3 TEMPORARY POWER

- A. The Contractor shall furnish temporary electrical power to maintain the normal operation of the facility as indicated on drawings. The Contractor shall coordinate with Owner for additional temporary electrical power needs.

3.4 USE OF OWNER EQUIPMENT

- A. The existing restroom facilities are designated for City employees. The Contractor shall provide temporary restroom facilities for their workforces and their sub-contractors forces.

3.5 ROUGH-IN

- A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
- B. All kitchen, lab, shop equipment, and process equipment shall be coordinated with final approved shop drawings before roughing-in any electrical work.
- C. If the required location of equipment, outlets, etc. differs from that indicated on the drawings, the Engineer shall determine the position of the equipment.
- D. The Engineer and/or Owner reserve the right to change the location of any receptacle, outlet, light fixture, panelboard, control equipment, motor, etc. to any point not over 10 feet distance from the location shown on the drawings without cost to the Owner. This Contractor shall verify final locations for the above-indicated equipment with the Owner or the Owner's representative prior to proceeding with any rough-in work.
- E. Refer to equipment specifications in Divisions 2 through 32 and approved product data and shop drawings for rough-in requirements.

3.6 ELECTRICAL INSTALLATIONS

- A. General: Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment. Comply with the following requirements:

1. Coordinate electrical systems, equipment, and materials installation with other building components.
2. Verify all dimensions by field measurements.
3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for electrical installations.
4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
5. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
7. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
8. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Engineer.
9. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces. Firmly support all materials and equipment.
10. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Install access panel or doors where units are concealed behind finished surfaces.
11. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

B. Performance of Equipment

1. All materials, equipment and appurtenances of any kind, shown on the drawings, hereinafter specified or required for the completion of the Project in accordance with the intent of these specifications, shall be completely satisfactory and acceptable in operation, performance, and capacity. No approval either in written or verbal of any drawings, descriptive data, or samples of such material, equipment and/or appurtenances shall relieve this Contractor of his responsibility to turn over the same to the Owner in perfect working order at the completion of the Project.
2. Any material, equipment or appurtenances, the operation, capacity or performance of which does not comply with the drawings and/or specification requirements or which is not new or which is damaged prior to acceptance by the Owner will be held to be defective material and shall be removed and replaced with the proper acceptable materials, equipment and/or appurtenances or put in proper acceptable working order, satisfactory to the Engineer with additional expense to the Owner.
3. All systems specified herein shall be furnished by manufacturers who have been regularly engaged in the manufacture of these products for a period of not less than five (5) years. This Contractor shall deliver to the Engineer, prior to final payment, a statement from the manufacturer or his authorized representative, certifying that the equipment has been inspected by him and found to be properly installed and functioning satisfactorily. Installation, final connections and testing of such systems shall be performed under the direct supervision of competent authorized service engineers who shall be in the employ of the respective equipment manufacturer. Any and all expenses incurred by these equipment manufacturer's representatives shall be borne by the Contractor.

4. All details of the installation of all equipment shall be electrically and mechanically correct. All equipment shall operate without objectionable noise or vibration should be produced and transmitted to occupied portions of the building by apparatus, conduit or other parts of a system, any corrections to eliminate noise and vibration shall be at no expense to the Owner.
- C. Any materials or workmanship found to be of inferior quality, damaged, improperly installed, or having been exposed to harmful substances or conditions at any time in the construction Work, shall be immediately replaced upon notification of the Contractor by the Engineer or Owner that such condition has been observed by the Engineer or Owner or his representatives.
- D. The Contractor shall at all times provide protective equipment as may become necessary to protect all parts of the work from damage or exposure to harmful conditions or contaminating substances.

3.7 **CUTTING AND PATCHING**

- A. General: Perform cutting and patching in accordance with Part 1 paragraph "Related Documents." In addition to the requirements referenced in the "Related Documents" paragraph, the following requirements apply:
 1. Quality Control
 - a. Craftsmanship: Workmen shall have a minimum five (5) years experience in working with materials being cut and patched.
 2. Materials
 - a. Unless otherwise indicated, use materials for patching that are identical in quality and texture to existing materials. If identical materials are not available or cannot be used, the use of substitute materials that match existing to the fullest extent possible with regard to visual effect and performance may be installed only where approved by the Engineer.
 - b. Reclaimed face brick and structural tile shall be used where possible.
 - c. Materials used for sealing openings shall have a fire rating equal to or greater than the rating of the floor, ceiling, or partition and shall comply with applicable codes. See Division 07 Section "Firestopping" for additional material and installation requirements.
 3. Perform cutting, fitting, and patching of electrical equipment and materials required to:
 - a. Uncover Work to provide for installation of ill-timed Work.
 - b. Remove and replace defective Work.
 - c. Remove and replace Work not conforming to requirements of the Contract Documents.
 - d. Install equipment and materials in existing structures.
 - e. Upon written instructions from the Engineer, uncover and restore Work to provide for Engineer observation of concealed Work.
 4. Cut, remove, and legally dispose of selected electrical equipment, components, and materials as indicated, including but not limited to removal of electrical items indicated to be removed and items made obsolete by the new Work.
 5. During cutting and patching operations, protect adjacent installations including, but not limited to, the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
 6. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas. Seal all openings utilized in plenum spaces, floors, ceilings, and/or partitions after the Work has been installed. Openings shall be suitably treated to prevent passage of stray light, air, or sound.
- B. Existing Facility
 1. General: Electrical Contractor shall be responsible for all cutting, patching, and finishing of existing construction for the proper installation of all electrical equipment and materials to be installed in the existing facility of this Project except as indicated below. The cutting and patching applies to both installation of new equipment and removal of existing equipment and materials.

- a. The General Contractor shall provide the cutting and patching at the following areas for all Contracts and shall coordinate the total number of openings required:
 - 1) Openings extending through exterior walls.
 - 2) Openings in the exterior wythes of exterior walls.
 - b. All cutting shall be kept to an absolute minimum consistent with the requirements of the Project.
 - c. Core drilling not permitted through motor floor.
 - d. No cutting shall be done which may affect the building structurally or architecturally including building systems without first securing the approval of the Engineer. Cutting shall be accomplished in such a manner as not to cause damage to the building or leave unsightly surfaces that cannot be concealed by plates, escutcheons, or other construction. Where unsightly conditions are caused, the Contractor shall be required, at his own expense, to repair the damaged areas.
 - 1) Cutting of the construction excessively or carelessly done shall be repaired by this Contractor to match the original work and to the satisfaction of the Engineer who will make the final decision with respect to excessive or careless cutting work.
 - e. Where existing equipment is removed and new equipment is installed utilizing the existing opening, the Contractor shall close up the unused portion of the opening.
 - f. Where existing equipment is removed, the Contractor shall patch and repair the existing partitions, floors, and ceilings including any existing openings that are no longer utilized by the removed equipment.
 - g. All patching shall match adjacent undisturbed areas perfectly and to the satisfaction of the Engineer.
 - h. Cutting and patching of the inner wythe of exterior walls where an opening does not extend through the outer wythe shall be by the Electrical Contractor. Where lintels are necessary, the Contractor shall coordinate opening with the Engineer for lintel sizes.
2. Cutting: Cut and remove existing construction only to the extent required by new Work and as indicated. Use methods required to complete Work within limitations of governing regulations and as follows:
- a. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. To minimize disturbance of adjacent surfaces, use hand or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
 - 1) All holes or openings for the passage of conduit to be provided in the existing concrete shall be bored.
 - b. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
 - c. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
 - d. Maintain adequate ventilation when using cutting torches.
 - e. Cut concrete and masonry at junctures with construction to remain, using power-driven masonry saw or hand tools; do not use power-driven impact tools.
3. Patching: All elements of construction and surfaces shall be returned to the same physical condition(s) existing prior to the start of cutting operations.
4. Painting
- a. Painting of the final finished areas will be by the Contractor as needed to restore final finishes to match existing. Paint wall or ceiling in entirety to closest edge or delineation and match existing colors. Coordinate with Engineer and Owner.

- b. All surfaces to be painted shall receive an undercoat 24 hours before the final coat is applied. Undercoats that show lumps or rough areas shall be smoothed with fine sandpaper or steel wool and dusted off before the final coat is applied. Final coat shall be solid, even color, free of lumps, drops, sags, run brush marks, laps, or other defects, finished to a line where they adjoin other colors or unpainted surfaces.
 - c. Drop cloths shall be used to protect floors and all other work from damage. Any covering temporarily removed from any part of the work or finish shall be promptly replaced and any damage from neglect to so protect all surfaces shall be made good at the Contractor's expense.
 - d. Paint color shall match adjoining surfaces as closely as possible and to the satisfaction of the Engineer.
- C. New Construction
 - 1. All openings or chases required for the installation of the Work in the new portion of the building shall be provided by the Electrical Contractor.
 - 2. The Electrical Contractor shall establish sizes and locations and shall coordinate with the General Contractor.
 - 3. The Electrical Contractor shall set all sleeves, hangers, and anchors required for his Work and shall be responsible for their proper and permanent location.
- D. Macadam and Concrete Areas
 - 1. Openings in concrete or macadam required for Electrical construction shall be made by taking extreme precautions to prevent excessive damage to existing facilities.
 - 2. Prior to completion, all disturbed areas shall be closed, restored to normal and finished to match surrounding areas.
- E. Clean Up: The Electrical Contractor shall daily remove all waste and debris resulting from his Work and shall immediately remove water present in the area resulting from the Work.

3.8 PROTECTION OF WORK, MATERIALS, AND EQUIPMENT

- A. This Contractor shall effectively protect at his own expense, all existing facilities and such of his new work, materials or equipment as is liable to injury during the construction period. All openings in to any part of the conduit system as well as all associated fixtures, equipment, etc. both before and after being set in place shall be securely covered or otherwise protected to prevent obstruction, damage, or injury due to carelessly or maliciously dropped tools or materials, grit, dirt moisture, water or any foreign matter. This Contractor shall be held responsible for all damage so done, until his work is fully accepted by the Engineer.
 - 1. Conduit ends shall be covered with capped bushings.
- B. All surfaces, either finished or in preparation for finishing or finish material application, shall be protected against damage from painting, welding, cutting, burning, soldering or similar construction functions. The protection shall be accomplished by care in operations, covering and shielding. Special care shall be directed to exposed finished masonry, metal or wood surfaces and painted surfaces. Corrective measures required shall be accomplished by the trade which made the original installation and shall be at the expense of the Contractor causing the damage with no cost to the Owner.
- C. Any damage caused by neglect on the part of this Contractor or his representative, or by the elements due to neglect on the part of this Contractor or his representatives, either to the existing work, or to his work or to the work of any other Contractor, shall be repaired at his expense to the Engineer's satisfaction.

3.9 RECYCLING AND DISPOSAL OF HAZARDOUS/CONTAMINATED MATERIAL

- A. General: All contaminated materials (i.e. ballasts, batteries, lamps, thermometers, transformers, etc.) removed by this Contract shall be properly recycled and/or disposed of pursuant to applicable laws enforced by the appropriate Federal and State governing agencies. All uncontaminated metal components shall be recycled, recovered, or reclaimed. The Contractor shall provide a manifest and a Certificate of Recycling and Disposal (CRD) as required by the governing agencies.
 - 1. Process: Hazardous and/or contaminated components shall be removed, segregated, and shipped for disposal/destruction at an EPA approved facility. Nonhazardous/uncontaminated components (glass, aluminum, copper, steel) shall be reclaimed for recycling.
 - 2. Material Tracking: All recycled or disposed material shall be tracked to ensure a that permanent record of proper disposal can be made readily available to the required governing agencies.
 - 3. Liability Coverage: \$5 million in General Liability and \$5 million in Pollution Liability with a fully funded closure fund.
 - 4. Permits: Contractor shall be EPA approved as a Commercial Holder of PCB waste and for and Alternative Disposal Method for ballast recycling. All lamp and PCB waste processing facilities shall be fully permitted.
- B. Hazardous/Contaminated Material
 - 1. Ballasts: The Contractor shall either test each ballast for PCB concentrations or assume that the ballast contains PCBs. If the ballast contains concentrations greater than 50 ppm, the ballast shall be disposed of at an EPA approved TSCA facility permitted for the Commercial Storage of PCB waste.
 - a. Note: Most ballasts manufactured before 1979 typically contained PCBs but this does not alleviate the Contractor from verifying that post 1979 ballasts do not contain PCBs.
 - 2. Batteries: The Contractor shall properly recycle and/or dispose of Alkaline, NiCad, Lead Acid and Lithium batteries which contain significant amounts of heavy metals including zinc, mercury, nickel, cadmium, selenium, steel and chrome and at a permitted recycling/disposal facility.
 - 3. Lamps: The Contractor shall recycle lamps that contain mercury at a permitted recycling facility or manage it as a fully regulated hazardous waste in accordance with EPA's Resource Recovery Act (RCRA) requirements.
 - a. Note: Mercury is currently used as a conductor in all fluorescent and HID lamps.
 - 4. Thermometers: The Contractor shall recycle all thermometers containing mercury.
 - 5. Transformers: The Contractor shall either test each transformer for PCB concentrations or assume that the transformer contains PCBs. If the transformer contains concentrations greater than 50 ppm, the transformer shall be disposed of at an EPA approved TSCA facility permitted for the Commercial Storage of PCB waste.
- C. This Contractor shall be responsible for all fees and payments associated with the removal and disposal of hazardous/contaminated electrical equipment.

3.10 START-UP AND TESTING

- A. Provide the services of a manufacturer's representative to start-up, adjust and test each piece of equipment. Refer to equipment specifications and specification section 26 05 10 for additional requirements.
- B. All start-up and testing shall be performed in the presence of the Owner and the Engineer. All start-up data and controls configuration and programming shall be recorded at start-up or training on approved data recording sheets and verified. Completed data sheets shall accompany the operations and maintenance manuals provided for use in training. Scheduling and coordination arrangements are to be made a minimum of two (2) weeks in advance, approved by the Owner.

3.11 CLEAN-UP

- A. Daily, and when directed by the Engineer, the Electrical Contractor shall remove all waste and debris resulting from his Work.
- B. Upon completion of his Work and when directed by the Engineer, the Electrical Contractor shall remove all dirt, foreign materials, stains, fingerprints, etc. from all equipment, light fixtures, panelboards, motor control centers, switchboards, variable frequency drives, cover plates, system equipment, etc., installed under this Contract. Internal areas of all equipment must be cleaned of all construction dust, debris, etc., prior to pre-final and/or final inspection.
 - 1. Clean paint, varnish spots and stains caused by finishing materials used by this Contractor from all walls, floors, ceilings, trim, glass, hardware, fixtures, masonry or any other surface that is damaged by this Contractor's Work.
 - 2. Do not use solvents that would remove or damage the finish of the finish hardware or other factory-finished materials. If damage occurs, the affected materials shall be returned to the factory for refinishing at not expense to the Owner.
- C. Repair all finishes damaged by this Contractor in areas that the General Contractor does not have any work and/or the General Contractor is not required to finish the space that was affected by this Contractor's Work and leave all work clean and perfect at completion such that no additional cleaning will be required by the Owner.

3.12 PROJECT SAFETY

- A. General: This Article pertains to any Work that may be performed on electrical equipment (new or existing). Contractor shall follow Owners safety requirements as provided under the attachment to the contract and Division 1.
- B. Contractor shall exert extreme caution in the disconnection and connection of all primary cables and high current carrying buses and cables on the secondaries of all transformers. All work on these facilities shall be done by mechanics skilled in this type of Work and in the necessary safety precautions for blocking out and locking and tagging of all breakers associated with the lines being worked on. All lines shall be tested for potential and grounding facilities that shall be applied on the line or cables being worked on.

3.13 INSTRUCTION AND TRAINING FOR THE OWNER'S PERSONNEL

- A. All statements of days or time periods required for training refer to actual time used to train the specified personnel and are exclusive of any travel, preparatory, delay, or lunch periods. Each day as stated in any requirement shall be considered to be eight (8) hours of actual training time and shall not be combined with start-up, testing, configuration, programming, or remediation activities. See individual Division 26 and other Division Sections including Division 1 and 26 01 80 for time period requirements for each piece of equipment and/or system.
- B. Prior to final inspection, instruct and train the Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Provide instruction and training at mutually agreed upon times.
 - 1. Instruction/training sessions shall be provided for the individual equipment and systems and shall include, but not be limited to, the following:
 - a. Theory of operation.
 - b. Maintenance.
 - c. Start-up.
 - d. Troubleshooting procedures.

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- e. Control and monitoring/metering systems with specific emphasis on use and performance of these systems in concert with the Owner's framework of controls and reporting systems.
2. All instruction/training shall be performed by qualified and manufacturer certified representatives.
- C. Use operation and maintenance manuals for each piece of equipment or system as the basis of instruction/training. Review contents in detail to explain all aspects of operation and maintenance.
 1. Operations and maintenance manuals shall be submitted prior to scheduling of instruction/training. Scheduling and commencement of instruction/training shall be contingent on the approved status of the O&M manuals. Unless noted otherwise, provide a minimum of three (3) O&M manuals with completed start-up and test data sheets for all equipment-training sessions.
- D. The instruction/training shall be provided for the following equipment and systems:
 1. Engine Generator and Transfer Switch.
 2. Surge Protection Devices (SPD).

3.14 SUBMITTALS CHART

A. Submittal List:

<u>DESCRIPTION OF ITEMS TO BE SUBMITTED</u>	<u>DIV</u>	<u>MFR</u>	<u>PROD</u>	<u>SHDR</u>	<u>DEDA</u>	<u>CERT</u>	<u>TEST</u>	<u>WARR</u>
<u>BOXES (INCLUDING JUNCTION, PULL AND OUTLET TYPE)</u>	<u>ALL</u>				<u>X</u>			
<u>CERTIFICATES AND/OR CERTIFICATIONS</u>	<u>ALL</u>					<u>X</u>		
<u>CONDUCTORS AND CABLES - LOW-VOLTAGE POWER AND INSTRUMENTATION</u>	<u>26</u>				<u>X</u>			
<u>CONDUIT (INCLUDING FITTINGS)</u>	<u>26</u>				<u>X</u>			
<u>COORDINATION DRAWING(S)</u>	<u>ALL</u>			<u>X</u>				
<u>FIELD TEST REPORTS</u>	<u>ALL</u>		<u>X</u>			<u>X</u>	<u>X</u>	
<u>GROUNDING</u>	<u>ALL</u>	<u>X</u>			<u>X</u>		<u>X</u>	
<u>HAZARDOUS DISPOSAL & RECYCLING CONTRACTORS</u>	<u>26</u>		<u>X</u>			<u>X</u>		
<u>IDENTIFICATION</u>	<u>ALL</u>	<u>X</u>			<u>X</u>			
<u>INSPECTION AGENCY - INDEPENDENT</u>	<u>ALL</u>		<u>X</u>			<u>X</u>		
<u>INSPECTION REPORT & CERTIFICATES</u>	<u>ALL</u>		<u>X</u>			<u>X</u>		
<u>OPERATION AND MAINTENANCE MANUALS</u>	<u>ALL</u>							<u>X</u>
<u>PANELBOARDS (INCLUDING OVERCURRENT PROTECTIVE DEVICES)</u>	<u>26</u>	<u>X</u>			<u>X</u>			
<u>MOTOR CONTROLLER</u>	<u>26</u>	<u>X</u>		<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>
<u>RACEWAY SUPPORTS (INCLUDING CONDUIT AND CABLE FASTENERS)</u>	<u>ALL</u>	<u>X</u>			<u>X</u>			
<u>RECORD DRAWINGS (DOCUMENTS)</u>	<u>ALL</u>							<u>X</u>
<u>RELAYS AND CONTACTORS</u>	<u>26</u>	<u>X</u>			<u>X</u>			

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<u>SAFETY SWITCHES - DISCONNECT SWITCHES</u>	<u>26</u>	<u>X</u>			<u>X</u>			
<u>SCHEDULE OF VALUES (DETAILED BREAKDOWN)</u>	<u>ALL</u>			<u>X</u>				
<u>SURGE PROTECTION DEVICES (SPD)</u>	<u>26</u>	<u>X</u>		<u>X</u>	<u>X</u>			<u>X</u>
<u>WARRANTIES (BOTH PROJECT AND EQUIPMENT)</u>	<u>ALL</u>							<u>X</u>
<u>WIRING DEVICES (INCLUDING DEVICE PLATES)</u>	<u>26</u>	<u>X</u>			<u>X</u>			
<u>ENGINE GENERATORS AND TRANSFER SWITCHES</u>	<u>26</u>	<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>

A. Abbreviations for the Submittal Chart

1. DIV - Specification Division
2. MFR - Manufacturer
3. PROD - Producer or Supplier
4. SHDR - Shop Drawings
5. DEDA - Descriptive Data or Catalog Cutsheets (Product Data)
6. CERT - Certification
7. TEST - Test Reports or Studies
8. WARR - Warranties

- B. The above submittal list is not intended to be all inclusive. Additional submittal items may be required by each Division 26 and Other Division specification section. Therefore, the Contractor shall review the "Submittals" paragraph for each Division Division 26, and Other Division specification sections for specific submission requirements and submit for review the appropriate product data and shop drawings as required by the "Submittals" paragraph including the submission items listed above.

END OF SECTION 26 01 00

SECTION 26 05 01**ELECTRICAL DEMOLITION****PART 1 GENERAL****1.1 SUMMARY**

- A. Section Includes: Selective demolition requirements for the electrical Work.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 26 Section "General Electrical Requirements" for additional cutting and patching requirements.

1.2 DEFINITIONS

- A. Disconnect: Disconnect electrical service to indicated items. Associated conduit and wire shall be disconnected and removed, complete, back to its source. Where electrical equipment (i.e. generator) is connected to radiator, fuel, and exhaust piping, intake and exhaust ductwork, etc., this Contractor shall disconnect and remove all associated appurtenances, complete, back to their source unless noted otherwise.
- B. Remove: Remove and legally dispose of items except those indicated to be reinstalled, salvaged, or to remain the Owner's property as directed.
- C. Salvage (Turn Over to Owner): Items indicated to be salvaged remain the Owner's property. Remove, clean, and pack or crate items to protect against damage. Identify contents of containers and deliver to Owner's designated storage area.

1.3 PROJECT CONDITIONS

- A. General: Demolition work, as specified herein, is not intended to be performed as a wrecking operation but as Work relative to the performance of the various construction operations of the Project. The Contractor shall perform a site investigation prior to submitting a bid and prior to performing any demolition or new work. Selective demolition shall include, but not be limited to:
 - 1. All labor, materials, and equipment required to perform selective demolition activities required by the Contract Documents.
 - 2. All labor, materials, and equipment to properly dispose of abandoned electrical equipment and apparatus as specified herein and as shown on the drawings.
- B. Protection: Exercise care during demolition work to confine demolition operations to the areas as indicated on the Drawings. The physical means and methods used for protection are at the Contractor's option. However, the Contractor shall be held completely responsible for replacement and restitution Work of whatever nature at no expense to the Owner.

1.4 SUBMITTALS

- A. Inventory of items removed and salvaged by the Contractor for the Owner for inclusion in the Operation and Maintenance Manuals.
- B. Identify and accurately locate capped utilities and other subsurface structural, electrical, or mechanical conditions on drawings at Project closeout according to Division 01.

1.5 QUALITY ASSURANCE

- A. Perform all electrical demolition work in accordance with all applicable Codes and Regulatory Agencies and Standards having jurisdiction.

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1.6 COORDINATION

- A. Coordinate the shut-off and disconnection of electrical service with the Owner and the utility company.
- B. Notify the Owner at least five days prior to commencing demolition operations.
- C. Arrange selective demolition so as not to interfere with Owner's on-site operations.
- D. Perform selective demolition in phases as indicated.

1.7 SEQUENCING AND SCHEDULING

- A. Coordinate selective demolition with other trades and schedule electrical appurtenance to be removed and de-energized to permit installation of new work.

PART 2 PRODUCTS**2.1 MATERIALS AND EQUIPMENT**

- A. Equipment, machinery and apparatus, motorized or otherwise, used to perform the demolition work may be used as chosen at the Contractor's discretion, but which will perform the Work within the limits of the Contract requirements.
- B. Patching Materials: Patching materials must match, as nearly as practical, the existing original structure material for each surface being patched.

PART 3 EXECUTION**3.1 GENERAL**

- A. Abandoned Electrical Equipment and Apparatus: Existing electrical equipment and apparatus in or on the structures shall become the property of the Contractor. The Contractor shall be responsible for reviewing the materials and equipment being assigned for removal and shall investigate for any contaminants or hazards; including, but not limited to, materials such as PCBs or asbestos. All material assigned to the Contractor shall be removed in a manner suitable to the Owner and may not be disposed of on the site but shall be disposed of off site in a lawful manner.
- B. Abandoned Work: Cut and remove buried raceway and wiring indicated to be abandoned in place, 2 inches below the surface of adjacent construction. Cap raceways and patch surface to match existing finish.
- C. Accessible Work: Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety. In exposed through-structure conduit locations, or where concealed conduits become exposed by penetrating a structural floor, wall or ceiling, the abandoned conduits shall be cut below the finished structural surface in order to perform surface patching.
- D. Cutting and Patching: Comply with requirements of Division 26 "General Electrical Requirements," Part 3 paragraph "Cutting and Patching" for additional patching requirements.
 - 1. Cutting: Perform cutting work of existing structure materials by such methods as will prevent extensive damage beyond the immediate area of cutting.
 - 2. Patching: After demolition and removal Work is performed, patch the existing structure as to match surrounding materials in finish, plane and appearance including the appropriate surface decoration.

- E. Disposal: Any such materials and equipment not desired by the Owner shall become the property of the Contractor and shall be removed promptly from the project site. Disposal shall be in accordance with the regulations of the authorities at the disposal site.
- F. Removed Non-Electrical Equipment: Disconnect and remove abandoned distribution equipment, devices, disconnect switches, motor starters, etc. serving utilization equipment that has been removed by others.
- G. Salvage: The Owner shall have the right to claim as salvage any items and materials removed under the Work of this Section in accordance with the Contract Documents. Should such right of salvage be exercised by the Owner, carefully handle, protect, move and neatly store removed items on the site in a location agreeable to the Owner, in a manner approved by the Engineer and/or Construction Manager. All materials not claimed as salvage by the Owner shall become the property of the Contractor, who shall consider the equipment and materials as Abandoned Electrical Equipment and Apparatus.

3.2 EXAMINATION

- A. Verify that field measurements and existing circuiting arrangements are as shown on Drawings.
 - 1. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
 - 2. Inventory and record the condition of items to be removed and salvaged.
 - 3. Survey the condition of the building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of the structure or adjacent structures during selective demolition.
 - 4. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.
- B. Verify that abandoned wiring and electrical equipment serve only abandoned facilities.
- C. Beginning of demolition operations shall mean that the Contractor accepts existing conditions.

3.3 PREPARATION

- A. General: Prior to removal or interception of any raceway or equipment, the Contractor shall positively de-energize, lockout, and safety tag all related safety equipment and energy sources, and verify all systems are safe for human contact and to prevent damage to any system equipment. The Contractor shall review emergency action plans with the Owner immediately before each excavation, removal, or disconnecting work proceeds, to prepare for contingency of encountering unexpected or hazardous conditions.
- B. System De-activation: Prior to performance of demolition and removal work, seek prior approval from the Owner and the Architect. After receiving direct authorization from the Owner, de-activate such existing electrical systems as indicated or as directed by the Architect.
 - 1. Use such means and methods for permanent disconnection that render the remaining electrical systems and apparatus in conformity with the National Electrical Code.
 - 2. System deactivation will be performed with direct authorization by the Owner and the Architect and shall be performed as directed or required by code and regulatory agency(s).
- C. Provide temporary wiring and connections to maintain existing systems in service during construction.
 - 1. Conform temporary wiring to the requirements of NEC Article 590.
 - 2. Provide temporary electrical service work as specified herein as shown on the drawings in order to maintain existing services and systems required for continued operation.
- D. Coordinate electrical power outages with requirements specified in the Contract Documents.

3.4 PERFORMANCE

- A. General: The means and methods of performing electrical demolition and removal operations are the sole responsibility of the Contractor, except as otherwise specified. However, equipment used, and methods of demolition and removal will be subject to approval of the Engineer.
1. Protection
 - a. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.
 - b. Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality as approved by the Architect.
 2. Locate, identify, and protect electrical services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.
 3. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.
- B. Demolition of existing electrical installation shall be performed to support the construction efforts of this Project. Demolish, remove, demount, and disconnect abandoned electrical materials and equipment indicated to be removed. Refer to drawings for further information.
1. Remove, relocate and extend existing installations to accommodate new construction as indicated and/or as required.
 2. Remove exposed abandoned conduit systems, including abandoned conduit systems above accessible ceiling systems.
 3. Remove wiring in abandoned conduit systems to source of power supply.
 4. Maintain access to existing electrical installations that remain active. Modify installations and provide access panels or plates as appropriate.
 5. Extend existing installations using materials and methods compatible with existing electrical installations, and as specified elsewhere.
- C. Electrical Materials and Equipment
1. Unintentional De-energization of Required Appurtenances: Any circuit and/or equipment indicated to be retained, and that is left de-energized because of the removal of existing equipment and materials, shall have a new homerun of required size extended to nearest panel and connected to a spare circuit breaker of required size therein. Total connected load on any one circuit breaker shall not exceed that required by the NEC.
 2. Boxes - Flush: Where devices (other than flush mounted light fixtures) and wiring are removed from existing flush boxes, a blank, stainless steel plate shall be provided and installed on the box by the Contractor.
 3. Circuits or Subfeeders: All circuits or subfeeders scheduled for removal shall be disconnected and removed to respective panelboards or the next retained outlet. If concealed conduits are encountered, they shall be cut at point of concealment and plugged with watertight and weatherproof caps as directed.
 4. Panelboards: Where existing flush mounted panelboards are indicated to be removed, they shall have their interiors and covers removed. This Contractor shall provide a new blank cover on the backbox.
 5. Wiring Devices: Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduits serving them is abandoned and removed. Provide blank covers for abandoned outlets that are not removed.

END OF SECTION 26 05 01

SECTION 26 05 10**ELECTRICAL ACCEPTANCE TESTING****ELECTRICAL ACCEPTANCE TESTING****1.1 TESTING SHALL BE PERFORMED ON ELECTRICAL EQUIPMENT AND SYSTEMS TO ASSURE THAT EQUIPMENT AND SYSTEMS ARE OPERATIONAL AND WITHIN APPLICABLE STANDARDS AND MANUFACTURER'S TOLERANCES. TESTING SHALL VERIFY THAT EQUIPMENT AND SYSTEMS ARE INSTALLED IN ACCORDANCE WITH DESIGN SPECIFICATIONS. ALL TESTING SHALL OCCUR AT THE SITE.**

- A. Testing shall be performed by an independent organization that is professionally independent of the manufacturers, suppliers, and installers of the equipment or systems being evaluated. The name of the proposed testing organization shall be submitted to Engineer for approval.
- B. Qualified technicians who are trained and regularly employed for testing services shall do all testing. Submit technician qualifications.
- C. The testing organization shall conform to the general guidelines of section 5 of the latest NETA Acceptance Testing Specifications, in their entirety. This includes the following:
 - 1. Safety and Precautions
 - 2. Suitability of Test Equipment
 - 3. Test Instrument Calibration
 - 4. Test Report
- D. Provide formal report with findings, recommendations, resolutions and supporting field data in clear and concise format, one (1) electronic PDF copy, and four (4) paper copies of the completed report to Owner and Engineer.
- E. Notify Owner at least seven (7) days in advance of any testing. An Owner representative shall witness the testing, if needed.
- F. Inspection and testing of all applicable electrical equipment listed below shall be done in accordance with the latest version of NETA ATS. This will include all tests marked optional unless waived in writing by Owner. In addition, follow testing requirements of each individual Division 26 Specification Section for each item in the project.
 - 1. Panelboards
 - 2. Cables: Low Voltage - Insulation Resistance / Voltage Drop
 - 3. Low Voltage Circuit Breakers:
 - a. Insulated Case/Molded Case (100 amp frame and larger)
 - 4. Grounding Systems
 - 5. Motor Starters: Low Voltage
 - 6. Surge Arresters
 - a. Low Voltage Surge Protection Devices
 - 7. Emergency Systems:
 - a. Engine Generator
 - b. Automatic Transfer Switches

1.2 SYSTEM FUNCTION TESTS

- A. Perform system function tests upon completion of equipment tests as defined in 26 05 10.01. It is the purpose of the system function tests to prove the correct interaction of all sensing, process, and action devices.
- B. Verify the correct operation of all safety devices for fail-safe functions in addition to design function.

- C. Verify the correct operation of all sensing devices, alarms, and indicating devices.

1.3 THERMOGRAPHIC SURVEY

- A. Perform a thermographic survey on all current carrying devices. Perform the survey during periods of maximum possible loading and prior to expiration of warranty or bond period.
- B. Imaging equipment shall be capable of detecting a minimum of 1-degree Celsius at 30 degrees Celsius.
- C. Level 2 certified thermographer shall perform the survey.
- D. A report shall be submitted to Owner and Engineer, which includes the following:
1. Description of equipment tested
 2. Discrepancies
 3. Temperature difference between area of concern and reference area
 4. Areas inspected
 5. Load conditions at time of inspection
 6. Provide photographs and/or thermograms of deficient areas
 7. Summary which includes recommendations for corrective actions.

1.4 VOLTAGE DROP TESTING

- A. A voltage test shall be made at the last receptacle of each branch circuit of each Panelboard. Total voltage drop shall not exceed 3% of the initial voltage measured at the end of that branch circuit. The test shall be made using a 12A load attached to the furthest receptacle. Contractor is responsible to correct any installation with a voltage drop of greater than 3%. If a branch circuit fails the test, all other branch circuits on that panel shall be tested. Submit all test results to Owner and Engineer.
- B. Documentation of the results shall be provided to Owner and Engineer.
- C. Any non-conforming branch circuits shall be corrected.

1.5 INSULATION RESISTANCE TESTING

- A. Cable/Conduit fails insulation resistance testing if cable results are below 1.0 Mega ohm readings on 500V DC or 1000V DC test equipment. Submit results to Engineer/Owner for review and interpretation. Advise Engineer on testing equipment used and test voltage. Resistance measurements are affected by temperature (ambient) and humidity.

END OF SECTION 26 05 10

SECTION 26 05 19**LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Single conductor building wire.
- B. Wiring connectors.
- C. Electrical tape.
- D. Heat shrink tubing.
- E. Wire pulling lubricant.
- F. Cable ties.

1.2 RELATED REQUIREMENTS

- A. Section 07 84 00 - Firestopping.
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.
- C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.3 REFERENCE STANDARDS

- A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2013.
- B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; 2011.
- C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010 (Reapproved 2014).
- D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation; 2004 (Reapproved 2014).
- E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- F. NEMA WC 70 - Nonshielded Power Cable 2000 V or Less for the Distribution of Electrical Energy; 2009.
- G. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2013.
- H. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- I. UL 44 - Thermoset-Insulated Wires and Cables; Current Edition, Including All Revisions.
- J. UL 83 - Thermoplastic-Insulated Wires and Cables; Current Edition, Including All Revisions.
- K. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.
- L. UL 486C - Splicing Wire Connectors; Current Edition, Including All Revisions.
- M. UL 486D - Sealed Wire Connector Systems; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
 - 2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
 - 3. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.
- B. Design Data: Indicate voltage drop and ampacity calculations for aluminum conductors substituted for copper conductors. Include proposed modifications to raceways, boxes, wiring gutters, enclosures, etc. to accommodate substituted conductors.
- C. Field Quality Control Test Reports.
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- E. Project Record Documents: Record actual installed circuiting arrangements. Record actual routing for underground circuits.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

1.8 FIELD CONDITIONS

- A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F, unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Engineer and obtain direction before proceeding with work.

PART 2 PRODUCTS**2.1 CONDUCTOR AND CABLE APPLICATIONS**

- A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.

- B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.

2.2 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.
- D. Comply with NEMA WC 70.
- E. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.
- F. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.
- G. Conductors for Grounding and Bonding: Also comply with Section 26 05 26.
- H. Conductor Material:
 - 1. Provide copper conductors only. Aluminum conductors are not acceptable for this project. Conductor sizes indicated are based on copper.
 - 2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
 - 3. Tinned Copper Conductors: Comply with ASTM B33.
- I. Minimum Conductor Size:
 - 1. Branch Circuits: 12 AWG.
 - a. Exceptions:
 - 1) 20 A, 120 V circuits longer than 75 feet: 10 AWG, for voltage drop.
 - 2) 20 A, 120 V circuits longer than 150 feet: 8 AWG, for voltage drop.
 - 2. Control Circuits: 14 AWG for digital circuits; 16 AWG for analog circuits.
- J. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- K. Conductor Color Coding:
 - 1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
 - 2. Color Coding Method: Integrally colored insulation.
 - a. Conductors size 4 AWG and larger may have black insulation color coded using vinyl color coding electrical tape.
 - 3. Color Code:
 - a. 208Y/120 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - 4) Neutral/Grounded: White.
 - b. 240/120 V, 1 Phase, 3 Wire System:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Neutral/Grounded: White.
 - c. Equipment Ground, All Systems: Green.

- d. For modifications or additions to existing wiring systems, comply with existing color code when existing code complies with NFPA 70 and is approved by the authority having jurisdiction.

2.3 SINGLE CONDUCTOR BUILDING WIRE

- A. Manufacturers:
 - 1. Copper Building Wire:
 - a. Cerro Wire LLC: www.cerrowire.com.
 - b. Encore Wire Corporation: www.encorewire.com.
 - c. General Cable Technologies Corporation: www.generalcable.com.
 - d. Southwire Company: www.southwire.com.
- B. Description: Single conductor insulated wire.
- C. Conductor Stranding:
 - 1. Feeders and Branch Circuits:
 - a. Size 10 AWG and Smaller: Solid.
 - b. Size 8 AWG and Larger: Stranded.
- D. Insulation Voltage Rating: 600 V.
- E. Insulation:
 - 1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2, except as indicated below.
 - a. Size 4 AWG and Larger: Type XHHW-2.
 - b. Installed Underground: Type XHHW-2.

2.4 WIRING CONNECTORS

- A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.
- B. Connectors for Grounding and Bonding: Comply with Section 26 05 26.
- C. Wiring Connectors for Splices and Taps:
 - 1. Copper Conductors Size 8 AWG and Smaller: Use twist-on insulated spring connectors.
- D. Wiring Connectors for Terminations:
 - 1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
 - 2. Provide compression adapters for connecting conductors to equipment furnished with mechanical lugs when only compression connectors are specified.
 - 3. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.
 - 4. Provide motor pigtail connectors for connecting motor leads in order to facilitate disconnection.
 - 5. Copper Conductors Size 8 AWG and Larger: Use mechanical connectors or compression connectors where connectors are required.
 - 6. Stranded Conductors Size 10 AWG and Smaller: Use crimped terminals for connections to terminal screws.
 - 7. Conductors for Control Circuits: Use crimped terminals for all connections.
- E. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.

- F. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.
- G. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F for standard applications and 302 degrees F for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.
 - 1. Manufacturers:
 - a. 3M: www.3m.com.
 - b. Ideal Industries, Inc: www.idealindustries.com.
 - c. NSI Industries LLC: www.nsiindustries.com.
- H. Mechanical Connectors: Provide bolted type or set-screw type.
 - 1. Manufacturers:
 - a. Burndy LLC: www.burndy.com.
 - b. IlSCO: www.ilsco.com.
 - c. Thomas & Betts Corporation: www.tnb.com.
- I. Compression Connectors: Provide circumferential type or hex type crimp configuration.
 - 1. Manufacturers:
 - a. Burndy LLC: www.burndy.com.
 - b. IlSCO: www.ilsco.com.
 - c. Thomas & Betts Corporation: www.tnb.com.
- J. Crimped Terminals: Nylon-insulated, with insulation grip and terminal configuration suitable for connection to be made.
 - 1. Manufacturers:
 - a. Burndy LLC: www.burndy.com.
 - b. IlSCO: www.ilsco.com.
 - c. Thomas & Betts Corporation: www.tnb.com.
- K. Low Voltage Motor Termination/Insulation Kit: Utilize lug connectors, insulated by means of Raychem, RVC Series (RAYVOLVE Insulating Splice Cover) pre-manufactured "roll-on" type insulation kits or equal products by Thomas and Betts. Voltage rating as required by the installation.

2.5 ACCESSORIES

- A. Electrical Tape:
 - 1. Manufacturers:
 - a. 3M: www.3m.com.
 - b. Plymouth Rubber Europa: www.plymouthrubber.com.
 - 2. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F.
 - 3. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F and suitable for continuous temperature environment up to 221 degrees F.
 - 4. Rubber Splicing Electrical Tape: Ethylene Propylene Rubber (EPR) tape, complying with ASTM D4388; minimum thickness of 30 mil; suitable for continuous temperature environment up to 194 degrees F and short-term 266 degrees F overload service.
 - 5. Electrical Filler Tape: Rubber-based insulating moldable putty, minimum thickness of 125 mil; suitable for continuous temperature environment up to 176 degrees F.

6. Varnished Cambric Electrical Tape: Cotton cambric fabric tape, with or without adhesive, oil-primed and coated with high-grade insulating varnish; minimum thickness of 7 mil; suitable for continuous temperature environment up to 221 degrees F.
 7. Moisture Sealing Electrical Tape: Insulating mastic compound laminated to flexible, all-weather vinyl backing; minimum thickness of 90 mil.
- B. Heat Shrink Tubing: Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; suitable for direct burial applications; listed as complying with UL 486D.
1. Manufacturers:
 - a. 3M: www.3m.com.
 - b. Burndy LLC: www.burndy.com.
 - c. Thomas & Betts Corporation: www.tnb.com.
- C. Wire Pulling Lubricant: Listed; suitable for use with the conductors or cables to be installed and suitable for use at the installation temperature.
1. Manufacturers:
 - a. 3M: www.3m.com.
 - b. American Polywater Corporation: www.polywater.com.
 - c. Ideal Industries, Inc: www.idealindustries.com.
- D. Cable Ties: Material and tensile strength rating suitable for application.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that interior of building has been protected from weather.
- B. Verify that work likely to damage wire and cable has been completed.
- C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.
- D. Verify that field measurements are as indicated.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

- A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.3 INSTALLATION

- A. Circuiting Requirements:
 1. Unless dimensioned, circuit routing indicated is diagrammatic.
 2. When circuit destination is indicated without specific routing, determine exact routing required.
 3. Arrange circuiting to minimize splices.
 4. Include circuit lengths required to install connected devices within 10 ft of location indicated.
 5. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
 6. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are indicated as separate, combining them together in a single raceway is permitted, under the following conditions:
 - a. Provide no more than six current-carrying conductors in a single raceway. Dedicated neutral conductors are considered current-carrying conductors.

- b. Increase size of conductors as required to account for ampacity derating.
 - c. Size raceways, boxes, etc. to accommodate conductors.
- 7. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.
- B. Install products in accordance with manufacturer's instructions.
- C. Perform work in accordance with NECA 1 (general workmanship).
- D. Installation in Raceway:
 - 1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
 - 2. Pull all conductors and cables together into raceway at same time.
 - 3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
 - 4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.
- E. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.
- F. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.
- G. Install conductors with a minimum of 12 inches of slack at each outlet.
- H. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.
- I. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.
- J. Make wiring connections using specified wiring connectors.
 - 1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
 - 2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
 - 3. Do not remove conductor strands to facilitate insertion into connector.
 - 4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminants. Do not use wire brush on plated connector surfaces.
 - 5. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 - 6. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- K. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
 - 1. Dry Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
 - a. For taped connections, first apply adequate amount of rubber splicing electrical tape or electrical filler tape, followed by outer covering of vinyl insulating electrical tape.
 - b. For taped connections likely to require re-entering, including motor leads, first apply varnished cambric electrical tape, followed by adequate amount of rubber splicing electrical tape, followed by outer covering of vinyl insulating electrical tape.

2. Damp Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
 - a. For connections with insulating covers, apply outer covering of moisture sealing electrical tape.
 - b. For taped connections, follow same procedure as for dry locations but apply outer covering of moisture sealing electrical tape.
 3. Wet Locations: Use heat shrink tubing.
- L. Insulate ends of spare conductors using vinyl insulating electrical tape.
- M. Field-Applied Color Coding: Where vinyl color coding electrical tape is used in lieu of integrally colored insulation as permitted in Part 2 under "Color Coding", apply half overlapping turns of tape at each termination and at each location conductors are accessible.
- N. Identify conductors and cables in accordance with Section 26 05 53.
- O. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.
- P. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

3.4 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS, except Section 4.
- B. Perform inspections and tests listed in NETA ATS, Section 7.3.2. The insulation resistance test is required for all conductors. The resistance test for parallel conductors listed as optional is not required.
 1. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.
- C. Perform thermographic survey.
- D. Correct deficiencies and replace damaged or defective conductors and cables.

END OF SECTION 26 05 19

SECTION 26 05 26**GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Grounding and bonding requirements.
- B. Conductors for grounding and bonding.
- C. Connectors for grounding and bonding.
- D. Ground bars.
- E. Ground rod electrodes.
- F. Ground access wells.

1.2 RELATED REQUIREMENTS

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.
- B. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.3 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- B. NEMA GR 1 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings; 2007.
- C. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2013.
- D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- E. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Verify exact locations of underground metal water service pipe entrances to building.
 - 2. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not install ground rod electrodes until final backfill and compaction is complete.

1.5 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system components.
- B. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

- C. Field quality control test reports.
- D. Project Record Documents: Record actual locations of grounding electrode system components and connections.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 GROUNDING AND BONDING REQUIREMENTS

- A. Existing Work: Where existing grounding and bonding system components are indicated to be reused, they may be reused only where they are free from corrosion, integrity and continuity are verified, and where acceptable to the authority having jurisdiction.
- B. Do not use products for applications other than as permitted by NFPA 70 and product listing.
- C. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.
- D. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- E. Grounding Electrode System:
 - 1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.
 - a. Provide continuous grounding electrode conductors without splice or joint.
 - b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.
 - 2. Metal Underground Water Pipe(s):
 - a. Provide connection to underground metal domestic and fire protection (where present) water service pipe(s) that are in direct contact with earth for at least 10 feet at an accessible location not more than 5 feet from the point of entrance to the building.
 - b. Provide bonding jumper(s) around insulating joints/pipes as required to make pipe electrically continuous.
 - c. Provide bonding jumper around water meter of sufficient length to permit removal of meter without disconnecting jumper.
 - 3. Ground Rod Electrode(s):
 - a. Provide three electrodes in an equilateral triangle configuration unless otherwise indicated or required.
 - b. Space electrodes not less than 10 feet from each other and any other ground electrode.

- c. Where location is not indicated, locate electrode(s) at least 5 feet outside building perimeter foundation as near as possible to electrical service entrance; where possible, locate in softscape (uncovered) area.
 - 4. Ground Bar: Provide ground bar, separate from service equipment enclosure, for common connection point of grounding electrode system bonding jumpers as permitted in NFPA 70. Connect grounding electrode conductor provided for service-supplied system grounding to this ground bar.
 - a. Ground Bar Size: 1/4 by 2 by 12 inches unless otherwise indicated or required.
 - b. Where ground bar location is not indicated, locate in accessible location as near as possible to service disconnect enclosure.
 - c. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.
- F. Service-Supplied System Grounding:
 - 1. For each service disconnect, provide grounding electrode conductor to connect neutral (grounded) service conductor to grounding electrode system. Unless otherwise indicated, make connection at neutral (grounded) bus in service disconnect enclosure.
 - 2. For each service disconnect, provide main bonding jumper to connect neutral (grounded) bus to equipment ground bus where not factory-installed. Do not make any other connections between neutral (grounded) conductors and ground on load side of service disconnect.
- G. Separately Derived System Grounding:
 - 1. Separately derived systems include, but are not limited to:
 - a. Generators, when neutral is switched in the transfer switch.
 - 2. Provide grounding electrode conductor to connect derived system grounded conductor to nearest effectively grounded metal building frame. Unless otherwise indicated, make connection at neutral (grounded) bus in source enclosure.
 - 3. Provide bonding jumper to connect derived system grounded conductor to nearest metal building frame and nearest metal water piping in the area served by the derived system, where not already used as a grounding electrode for the derived system. Make connection at same location as grounding electrode conductor connection.
 - 4. Where common grounding electrode conductor ground riser is used for tap connections to multiple separately derived systems, provide bonding jumper to connect the metal building frame and metal water piping in the area served by the derived system to the common grounding electrode conductor.
 - 5. Provide system bonding jumper to connect system grounded conductor to equipment ground bus. Make connection at same location as grounding electrode conductor connection. Do not make any other connections between neutral (grounded) conductors and ground on load side of separately derived system disconnect.
 - 6. Where the source and first disconnecting means are in separate enclosures, provide supply-side bonding jumper between source and first disconnecting means.
- H. Bonding and Equipment Grounding:
 - 1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
 - 2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
 - 3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
 - 4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.

5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
7. Provide bonding for interior metal piping systems in accordance with NFPA 70. This includes, but is not limited to:
 - a. Metal water piping where not already effectively bonded to metal underground water pipe used as grounding electrode.
8. Provide bonding for metal building frame.

2.2 GROUNDING AND BONDING COMPONENTS

- A. General Requirements:
 1. Provide products listed, classified, and labeled as suitable for the purpose intended.
 2. Provide products listed and labeled as complying with UL 467 where applicable.
- B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 26 05 26:
 1. Use insulated copper conductors unless otherwise indicated.
 - a. Exceptions:
 - 1) Use bare copper conductors where installed underground in direct contact with earth.
 - 2) Use bare copper conductors where directly encased in concrete (not in raceway).
- C. Connectors for Grounding and Bonding:
 1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
 2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
 - a. Exceptions:
 - 1) Use mechanical connectors for connections to electrodes at ground access wells.
 3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.
 - a. Exceptions:
 - 1) Use exothermic welded connections for connections to metal building frame.
 4. Manufacturers - Mechanical and Compression Connectors:
 - a. Advanced Lightning Technology (ALT): www.altfab.com.
 - b. Burndy LLC: www.burndy.com.
 - c. Harger Lightning & Grounding: www.harger.com.
 - d. Thomas & Betts Corporation: www.tnb.com.
 5. Manufacturers - Exothermic Welded Connections:
 - a. Burndy LLC: www.burndy.com.
 - b. Cadweld, a brand of Erico International Corporation: www.erico.com.
 - c. thermOweld, subsidiary of Continental Industries; division of Burndy LLC: www.thermoweld.com.
- D. Ground Bars:
 1. Description: Copper rectangular ground bars with mounting brackets and insulators.
 2. Size: As indicated.
 3. Holes for Connections: As indicated or as required for connections to be made.
 4. Manufacturers:
 - a. Advanced Lightning Technology (ALT): www.altfab.com.
 - b. Erico International Corporation: www.erico.com.
 - c. Harger Lightning & Grounding: www.harger.com.

- d. thermOweld, subsidiary of Continental Industries; division of Burndy LLC:
www.thermoweld.com.
- E. Ground Rod Electrodes:
 - 1. Comply with NEMA GR 1.
 - 2. Material: Copper-bonded (copper-clad) steel.
 - 3. Size: 3/4 inch diameter by 10 feet length, unless otherwise indicated.
 - 4. Manufacturers:
 - a. Advanced Lightning Technology (ALT): www.altfab.com.
 - b. Erico International Corporation: www.erico.com.
 - c. Galvan Industries, Inc: www.galvanelectrical.com.
 - d. Harger Lightning & Grounding: www.harger.com.
- F. Ground Access Wells:
 - 1. Description: Open bottom round or rectangular well with access cover for testing and inspection; suitable for the expected load at the installed location.
 - 2. Size: As required to provide adequate access for testing and inspection, but not less than minimum size requirements specified.
 - a. Round Wells: Not less than 8 inches in diameter.
 - b. Rectangular Wells: Not less than 12 by 12 inches.
 - 3. Depth: As required to extend below frost line to prevent frost upheaval, but not less than 10 inches.
 - 4. Cover: Factory-identified by permanent means with word "GROUND".
 - 5. Manufacturers:
 - a. Advanced Lightning Technology (ALT): www.altfab.com.
 - b. Erico International Corporation: www.erico.com.
 - c. Harger Lightning & Grounding: www.harger.com.
 - d. thermOweld, subsidiary of Continental Industries; division of Burndy LLC:
www.thermoweld.com.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that work likely to damage grounding and bonding system components has been completed.
- B. Verify that field measurements are as indicated.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70 or provide ground plates.
 - 1. Outdoor Installations: Unless otherwise indicated, install with top of rod 6 inches below finished grade.
- D. Make grounding and bonding connections using specified connectors.

1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
 2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
 3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
 4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- E. Identify grounding and bonding system components in accordance with Section 26 05 53.

3.3 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS except Section 4.
- B. Perform inspections and tests listed in NETA ATS, Section 7.13.
- C. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.
- D. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.
- E. Submit detailed reports indicating inspection and testing results and corrective actions taken.

END OF SECTION 26 05 26

SECTION 26 05 29**HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Support and attachment requirements and components for equipment, conduit, cable, boxes, and other electrical work.

1.2 RELATED REQUIREMENTS

- A. Section 26 05 33.13 - Conduit for Electrical Systems: Additional support and attachment requirements for conduits.
- B. Section 26 05 33.16 - Boxes for Electrical Systems: Additional support and attachment requirements for boxes.

1.3 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2015.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2009.
- C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2013.
- D. MFMA-4 - Metal Framing Standards Publication; 2004.
- E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. UL 5B - Strut-Type Channel Raceways and Fittings; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
 - 2. Coordinate the work with other trades to provide additional framing and materials required for installation.
 - 3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
 - 4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
 - 5. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for post-installed concrete and masonry anchors.

- B. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.6 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. Comply with applicable building code.
- C. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 SUPPORT AND ATTACHMENT COMPONENTS

- A. General Requirements:
 - 1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
 - 2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
 - 3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.
 - 4. Do not use products for applications other than as permitted by NFPA 70 and product listing.
 - 5. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
 - 6. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
 - a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
 - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.
 - c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.
 - 1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
 - 2. Conduit Clamps: Bolted type unless otherwise indicated.
 - 3. Manufacturers:
 - a. Cooper Crouse-Hinds, a division of Eaton Corporation: www.cooperindustries.com.
 - b. Erico International Corporation: www.erico.com.

- c. HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com.
 - d. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com.
 - e. Thomas & Betts Corporation: www.tnb.com.
- C. Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.
 - 1. Manufacturers:
 - a. Cooper Crouse-Hinds, a division of Eaton Corporation: www.cooperindustries.com.
 - b. Erico International Corporation: www.erico.com.
 - c. HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com.
 - d. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com.
 - e. Thomas & Betts Corporation: www.tnb.com.
- D. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
 - 1. Comply with MFMA-4.
 - 2. Channel (Strut) Used as Raceway (only where specifically indicated): Listed and labeled as complying with UL 5B.
 - 3. Channel Material:
 - a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.
 - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
 - 4. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch.
 - 5. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height.
 - 6. Manufacturers:
 - a. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com.
 - b. Thomas & Betts Corporation: www.tnb.com.
 - c. Unistrut, a brand of Atkore International Inc: www.unistrut.com.
 - d. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.
- E. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
 - 1. Minimum Size, Unless Otherwise Indicated or Required:
 - a. Equipment Supports: 1/2 inch diameter.
 - b. Single Conduit up to 1 inch (27 mm) trade size: 1/4 inch diameter.
 - c. Single Conduit larger than 1 inch (27 mm) trade size: 3/8 inch diameter.
 - d. Trapeze Support for Multiple Conduits: 3/8 inch diameter.
- F. Anchors and Fasteners:
 - 1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
 - 2. Concrete: Use expansion anchors or screw anchors.
 - 3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
 - 4. Hollow Masonry: Use toggle bolts.
 - 5. Powder-actuated fasteners are not permitted.
 - 6. Hammer-driven anchors and fasteners are not permitted.
 - 7. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.
 - 8. Manufacturers - Mechanical Anchors:
 - a. Hilti, Inc: www.us.hilti.com.
 - b. ITW Red Head, a division of Illinois Tool Works, Inc: www.itwredhead.com.
 - c. Powers Fasteners, Inc: www.powers.com.
 - d. Simpson Strong-Tie Company Inc: www.strongtie.com.

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PART 3 EXECUTION**3.1 EXAMINATION**

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive support and attachment components.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.
- D. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- E. Unless specifically indicated or approved by Engineer, do not provide support from suspended ceiling support system or ceiling grid.
- F. Unless specifically indicated or approved by Engineer, do not provide support from roof deck.
- G. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- H. Equipment Support and Attachment:
 - 1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
 - 2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
 - 3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
 - 4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- I. Conduit Support and Attachment: Also comply with Section 26 05 33.13.
- J. Box Support and Attachment: Also comply with Section 26 05 33.16.
- K. Secure fasteners according to manufacturer's recommended torque settings.
- L. Remove temporary supports.

3.3 FIELD QUALITY CONTROL

- A. Inspect support and attachment components for damage and defects.
- B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- C. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION 26 05 29

SECTION 26 05 33.13**CONDUIT FOR ELECTRICAL SYSTEMS****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Galvanized steel rigid metal conduit (RMC).
- B. PVC-coated galvanized steel rigid metal conduit (RMC).
- C. Flexible metal conduit (FMC).
- D. Liquidtight flexible metal conduit (LFMC).
- E. Electrical metallic tubing (EMT).
- F. Rigid polyvinyl chloride (PVC) conduit.
- G. Conduit fittings.
- H. Accessories.

1.2 RELATED REQUIREMENTS

- A. Section 07 84 00 - Firestopping.
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- C. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 31 23 17 - Trenching, Backfilling, and Compacting.

1.3 REFERENCE STANDARDS

- A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2005.
- B. ANSI C80.3 - American National Standard for Steel Electrical Metallic Tubing (EMT); 2005.
- C. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- D. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); 2013.
- E. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC); 2003.
- F. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2012.
- G. NEMA RN 1 - Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit; 2005.
- H. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; 2013.
- I. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; 2015.
- J. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

- K. UL 1 - Flexible Metal Conduit; Current Edition, Including All Revisions.
- L. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.
- M. UL 360 - Liquid-Tight Flexible Steel Conduit; Current Edition, Including All Revisions.
- N. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.
- O. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings; Current Edition, Including All Revisions.
- P. UL 797 - Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate minimum sizes of conduits with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
 - 2. Coordinate the arrangement of conduits with structural members, ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
 - 3. Verify exact conduit termination locations required for boxes, enclosures, and equipment installed under other sections or by others.
 - 4. Coordinate the work with other trades to provide roof penetrations that preserve the integrity of the roofing system and do not void the roof warranty.
 - 5. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not begin installation of conductors and cables until installation of conduit is complete between outlet, junction and splicing points.

1.5 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.
- B. Shop Drawings:
 - 1. Indicate proposed arrangement for conduits to be installed within structural concrete slabs, where permitted.
 - 2. Include proposed locations of roof penetrations and proposed methods for sealing.
- C. Project Record Documents: Record actual routing for conduits installed underground, conduits embedded within concrete slabs, and conduits 2 inch (53 mm) trade size and larger.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.

PART 2 PRODUCTS**2.1 CONDUIT APPLICATIONS**

- A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70 and product listing.
- B. Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications. Where more than one listed application applies, comply with the most restrictive requirements. Where conduit type for a particular application is not specified, use galvanized steel rigid metal conduit.
- C. Underground:
 - 1. Under Slab on Grade: Use PVC-coated galvanized steel rigid metal conduit or rigid PVC conduit.
 - 2. Exterior, Direct-Buried: Use PVC-coated galvanized steel rigid metal conduit or rigid PVC conduit.
 - 3. Where rigid polyvinyl (PVC) conduit is provided, transition to PVC-coated galvanized steel rigid metal conduit where emerging from underground.
 - 4. Where rigid polyvinyl (PVC) conduit larger than 2 inch (53 mm) trade size is provided, use PVC-coated galvanized steel rigid metal conduit elbows for bends.
- D. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit.
- E. Exposed, Interior: Use galvanized steel rigid metal conduit or electrical metallic tubing (EMT).
- F. Exposed, Exterior: Use PVC-coated galvanized steel rigid metal conduit.
- G. Connections to Vibrating Equipment:
 - 1. Dry Locations: Use flexible metal conduit.
 - 2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit.
 - 3. Maximum Length: 6 feet unless otherwise indicated.
 - 4. Vibrating equipment includes, but is not limited to:
 - a. Motors.

2.2 CONDUIT REQUIREMENTS

- A. Existing Work: Where existing conduits are indicated to be reused, they may be reused only where they comply with specified requirements, are free from corrosion, and integrity is verified by pulling a mandrel through them.
- B. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.
- C. Provide products listed, classified, and labeled as suitable for the purpose intended.
- D. Minimum Conduit Size, Unless Otherwise Indicated:
 - 1. Branch Circuits: 3/4 inch (21 mm) trade size.
 - 2. Branch Circuit Homeruns: 3/4 inch (21 mm) trade size.
 - 3. Underground, Exterior: 1 inch (27 mm) trade size.
- E. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.3 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Manufacturers:
 - 1. Allied Tube & Conduit: www.alliedeg.com.

2. Republic Conduit: www.republic-conduit.com.
 3. Wheatland Tube, a Division of Zekelman Industries: www.wheatland.com.
- B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.
- C. Fittings:
1. Manufacturers:
 - a. Bridgeport Fittings Inc: www.bptfittings.com.
 - b. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com.
 - c. Thomas & Betts Corporation: www.tnb.com.
 2. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 3. Material: Use steel or malleable iron.
 - a. Do not use die cast zinc fittings.
 4. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.4 PVC-COATED GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Manufacturers:
1. Thomas & Betts Corporation: www.tnb.com.
 2. Robroy Industries: www.robroy.com.
- B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit with external polyvinyl chloride (PVC) coating complying with NEMA RN 1 and listed and labeled as complying with UL 6.
- C. Exterior Coating: Polyvinyl chloride (PVC), nominal thickness of 40 mil.
- D. Interior Coating: Urethane, minimum thickness of 2 mil.
- E. PVC-Coated Fittings:
1. Manufacturer: Same as manufacturer of PVC-coated conduit to be installed.
 2. Non-Hazardous Locations: Use fittings listed and labeled as complying with UL 514B.
 3. Material: Use steel or malleable iron.
 4. Exterior Coating: Polyvinyl chloride (PVC), minimum thickness of 40 mil.
 5. Interior Coating: Urethane, minimum thickness of 2 mil.
- F. PVC-Coated Supports: Furnish with exterior coating of polyvinyl chloride (PVC), minimum thickness of 15 mil.

2.5 FLEXIBLE METAL CONDUIT (FMC)

- A. Manufacturers:
1. AFC Cable Systems, Inc: www.afcweb.com.
 2. Electri-Flex Company: www.electriflex.com.
 3. International Metal Hose: www.metalhose.com.
- B. Description: NFPA 70, Type FMC standard wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems to be used.
- C. Fittings:
1. Manufacturers:
 - a. Bridgeport Fittings Inc: www.bptfittings.com.
 - b. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com.

- c. Thomas & Betts Corporation: www.tnb.com.
- 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
- 3. Material: Use steel or malleable iron.
 - a. Do not use die cast zinc fittings.

2.6 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

- A. Manufacturers:
 - 1. AFC Cable Systems, Inc: www.afcweb.com.
 - 2. Electri-Flex Company: www.electriflex.com.
 - 3. International Metal Hose: www.metalhose.com.
- B. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.
- C. Fittings:
 - 1. Manufacturers:
 - a. Bridgeport Fittings Inc: www.bptfittings.com.
 - b. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com.
 - c. Thomas & Betts Corporation: www.tnb.com.
 - 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 3. Material: Use steel or malleable iron.
 - a. Do not use die cast zinc fittings.

2.7 ELECTRICAL METALLIC TUBING (EMT)

- A. Manufacturers:
 - 1. Allied Tube & Conduit: www.alliedeg.com.
 - 2. Republic Conduit: www.republic-conduit.com.
 - 3. Wheatland Tube, a Division of Zekelman Industries: www.wheatland.com.
- B. Description: NFPA 70, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.
- C. Fittings:
 - 1. Manufacturers:
 - a. Bridgeport Fittings Inc: www.bptfittings.com.
 - b. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com.
 - c. Thomas & Betts Corporation: www.tnb.com.
 - 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 3. Material: Use steel or malleable iron.
 - a. Do not use die cast zinc fittings.
 - 4. Connectors and Couplings: Use compression (gland) type.
 - a. Do not use indenter type connectors and couplings.
 - b. Do not use set-screw type connectors and couplings.

2.8 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

- A. Manufacturers:
 - 1. Cantex Inc: www.cantexinc.com.
 - 2. Carlon, a brand of Thomas & Betts Corporation: www.carlon.com.

3. JM Eagle: www.jmeagle.com.
- B. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage; rated for use with conductors rated 90 degrees C.
- C. Fittings:
 1. Manufacturer: Same as manufacturer of conduit to be connected.
 2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.

2.9 ACCESSORIES

- A. Conduit Joint Compound: Corrosion-resistant, electrically conductive; suitable for use with the conduit to be installed.
- B. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.
- C. Pull Strings: Use nylon cord with average breaking strength of not less than 200 pound-force.
- D. Sealing Compound for Sealing Fittings: Listed for use with the particular fittings to be installed.
- E. Modular Seals for Conduit Penetrations: Rated for minimum of 40 psig; Suitable for the conduits to be installed.
- F. Duct Bank Spacers: Nonmetallic; designed for maintaining conduit/duct spacing for concrete encasement in open trench installation; suitable for the conduit/duct arrangement to be installed.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive conduits.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.
- D. Install PVC-coated galvanized steel rigid metal conduit (RMC) using only tools approved by the manufacturer.
- E. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.
- F. Conduit Routing:
 1. Unless dimensioned, conduit routing indicated is diagrammatic.
 2. When conduit destination is indicated without specific routing, determine exact routing required.
 3. Conceal all conduits unless specifically indicated to be exposed.
 4. Conduits in the following areas may be exposed, unless otherwise indicated:
 - a. Electrical rooms.

- b. Mechanical equipment rooms.
 - 5. Unless otherwise approved, do not route conduits exposed:
 - a. Across floors.
 - b. Across roofs.
 - c. Across top of parapet walls.
 - d. Across building exterior surfaces.
 - 6. Conduits installed underground or embedded in concrete may be routed in the shortest possible manner unless otherwise indicated. Route all other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.
 - 7. Arrange conduit to maintain adequate headroom, clearances, and access.
 - 8. Arrange conduit to provide no more than the equivalent of four 90 degree bends between pull points.
 - 9. Arrange conduit to provide no more than 150 feet between pull points.
 - 10. Route conduits above water and drain piping where possible.
 - 11. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
 - 12. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
 - 13. Maintain minimum clearance of 12 inches between conduits and hot surfaces. This includes, but is not limited to:
 - a. Heaters.
 - b. Hot water piping.
 - c. Flues.
 - 14. Group parallel conduits in the same area together on a common rack.
- G. Conduit Support:
- 1. Secure and support conduits in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
 - 2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
 - 3. Use conduit strap to support single surface-mounted conduit.
 - a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
 - 4. Use metal channel (strut) with accessory conduit clamps to support multiple parallel surface-mounted conduits.
 - 5. Use conduit clamp to support single conduit from beam clamp or threaded rod.
 - 6. Use trapeze hangers assembled from threaded rods and metal channel (strut) with accessory conduit clamps to support multiple parallel suspended conduits.
 - 7. Use of spring steel conduit clips for support of conduits is permitted only as follows:
 - a. Support of electrical metallic tubing (EMT) up to 1 inch (27 mm) trade size concealed above accessible ceilings and within hollow stud walls.
 - 8. Use of wire for support of conduits is not permitted.
 - 9. Where conduit support intervals specified in NFPA 70 and NECA standards differ, comply with the most stringent requirements.
- H. Connections and Terminations:
- 1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
 - 2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
 - 3. Use suitable adapters where required to transition from one type of conduit to another.

4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
 5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
 6. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.
 7. Secure joints and connections to provide maximum mechanical strength and electrical continuity.
- I. Penetrations:
1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
 2. Make penetrations perpendicular to surfaces unless otherwise indicated.
 3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
 4. Conceal bends for conduit risers emerging above ground.
 5. Seal interior of conduits entering the building from underground at first accessible point to prevent entry of moisture and gases.
 6. Provide suitable modular seal where conduits penetrate exterior wall below grade.
 7. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
 8. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty. Include proposed locations of penetrations and methods for sealing with submittals.
 9. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.
- J. Underground Installation:
1. Provide trenching and backfilling in accordance with Section 31 23 17.
 2. Minimum Cover, Unless Otherwise Indicated or Required:
 - a. Underground, Exterior: 24 inches.
 - b. Under Slab on Grade: 12 inches to bottom of slab.
- K. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
 2. Where calculated in accordance with NFPA 70 for rigid polyvinyl chloride (PVC) conduit installed above ground to compensate for thermal expansion and contraction.
 3. Where conduits are subject to earth movement by settlement or frost.
- L. Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide sealing fitting or approved sealing compound at an accessible point near the penetration to prevent condensation. This includes, but is not limited to:
1. Where conduits pass from outdoors into conditioned interior spaces.
 2. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
- M. Provide pull string in all empty conduits and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches at each end.
- N. Provide grounding and bonding in accordance with Section 26 05 26.
- O. Identify conduits in accordance with Section 26 05 53.

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3.3 FIELD QUALITY CONTROL

- A. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- B. Where coating of PVC-coated galvanized steel rigid metal conduit (RMC) contains cuts or abrasions, repair in accordance with manufacturer's instructions.
- C. Correct deficiencies and replace damaged or defective conduits.

3.4 CLEANING

- A. Clean interior of conduits to remove moisture and foreign matter.

3.5 PROTECTION

- A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

END OF SECTION 26 05 33.13

SECTION 26 05 33.16**BOXES FOR ELECTRICAL SYSTEMS****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.
- B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.

1.2 RELATED REQUIREMENTS

- A. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- B. Section 26 05 33.13 - Conduit for Electrical Systems:
 - 1. Conduit bodies and other fittings.
 - 2. Additional requirements for locating boxes to limit conduit length and/or number of bends between pulling points.
- C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- D. Section 26 27 26 - Wiring Devices:
 - 1. Wall plates.

1.3 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- B. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2010.
- C. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2012.
- D. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; 2013.
- E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
- F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- H. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- I. UL 508A - Industrial Control Panels; Current Edition, Including All Revisions.
- J. UL 514A - Metallic Outlet Boxes; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.

2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
6. Coordinate the work with other trades to preserve insulation integrity.
7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.
8. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for outlet and device boxes, junction and pull boxes, and cabinets and enclosures.
- B. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- C. Project Record Documents: Record actual locations for junction boxes, pull boxes, and cabinets and enclosures.
- D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 2. Keys for Lockable Enclosures: Two of each different key.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 BOXES

- A. General Requirements:
 1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
 2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
 3. Provide products listed, classified, and labeled as suitable for the purpose intended.
 4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

5. Provide grounding terminals within boxes where equipment grounding conductors terminate.
- B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:
 1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
 2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
 3. Use suitable concrete type boxes where flush-mounted in concrete.
 4. Use suitable masonry type boxes where flush-mounted in masonry walls.
 5. Use raised covers suitable for the type of wall construction and device configuration where required.
 6. Use shallow boxes where required by the type of wall construction.
 7. Do not use "through-wall" boxes designed for access from both sides of wall.
 8. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
 9. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
 10. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
 11. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes unless specifically indicated or permitted.
 12. Minimum Box Size, Unless Otherwise Indicated:
 - a. Wiring Devices: 4 inch square by 1-1/2 inch deep (100 by 38 mm) trade size.
 13. Wall Plates: Comply with Section 26 27 26.
 14. Manufacturers:
 - a. Cooper Crouse-Hinds, a division of Eaton Corporation: www.cooperindustries.com.
 - b. Hubbell Incorporated; Bell Products: www.hubbell-rtb.com.
 - c. Hubbell Incorporated; RACO Products: www.hubbell-rtb.com.
 - d. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com.
 - e. Thomas & Betts Corporation: www.tnb.com.
- C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:
 1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
 2. NEMA 250 Environment Type, Unless Otherwise Indicated:
 - a. Indoor Clean, Dry Locations: Type 1, painted steel.
 - b. Outdoor Locations: Type 3R, painted steel.
 3. Junction and Pull Boxes Larger Than 100 cubic inches:
 - a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.
 - b. Boxes 6 square feet and Larger: Provide sectionalized screw-cover or hinged-cover enclosures.
 4. Cabinets and Hinged-Cover Enclosures, Other Than Junction and Pull Boxes:
 - a. Provide lockable hinged covers, all locks keyed alike unless otherwise indicated.
 - b. Back Panels: Painted steel, removable.
 - c. Terminal Blocks: Provide voltage/current ratings and terminal quantity suitable for purpose indicated, with 25 percent spare terminal capacity.
 5. Finish for Painted Steel Enclosures: Manufacturer's standard grey unless otherwise indicated.
 6. Manufacturers:
 - a. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com.
 - b. Hoffman, a brand of Pentair Technical Products: www.hoffmanonline.com.
 - c. Hubbell Incorporated; Wiegmann Products: www.hubbell-wiegmann.com.

PART 3 EXECUTION**3.1 EXAMINATION**

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive boxes.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install boxes in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide separate boxes for emergency power and normal power systems.
- E. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.
- F. Unless otherwise indicated, boxes may be surface-mounted where exposed conduits are indicated or permitted.
- G. Box Locations:
 - 1. Unless dimensioned, box locations indicated are approximate.
 - 2. Locate boxes as required for devices installed under other sections or by others.
 - 3. Locate boxes so that wall plates do not span different building finishes.
 - 4. Locate boxes so that wall plates do not cross masonry joints.
 - 5. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.
 - 6. Do not install flush-mounted boxes on opposite sides of walls back-to-back. Provide minimum 6 inches horizontal separation unless otherwise indicated.
 - 7. Locate junction and pull boxes as indicated, as required to facilitate installation of conductors, and to limit conduit length and/or number of bends between pulling points in accordance with Section 26 05 33.13.
 - 8. Locate junction and pull boxes in the following areas, unless otherwise indicated:
 - a. Electrical rooms.
 - b. Mechanical equipment rooms.
- H. Box Supports:
 - 1. Secure and support boxes in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
 - 2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.
- I. Install boxes plumb and level.
- J. Flush-Mounted Boxes:

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1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.
 2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
 3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.
- K. Install boxes as required to preserve insulation integrity.
- L. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- M. Close unused box openings.
- N. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.
- O. Provide grounding and bonding in accordance with Section 26 05 26.
- P. Identify boxes in accordance with Section 26 05 53.

3.3 CLEANING

- A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

3.4 PROTECTION

- A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION 26 05 33.16

SECTION 26 05 53**IDENTIFICATION FOR ELECTRICAL SYSTEMS****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Electrical identification requirements.
- B. Identification nameplates and labels.
- C. Wire and cable markers.
- D. Voltage markers.
- E. Underground warning tape.
- F. Floor marking tape.
- G. Warning signs and labels.

1.2 RELATED REQUIREMENTS

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.

1.3 REFERENCE STANDARDS

- A. ANSI Z535.2 - American National Standard for Environmental and Facility Safety Signs; 2011.
- B. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels; 2011.
- C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. UL 969 - Marking and Labeling Systems; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.
- B. Sequencing:
 - 1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
 - 2. Do not install identification products until final surface finishes and painting are complete.

1.5 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.
- B. Shop Drawings: Provide schedule of items to be identified indicating proposed designations, materials, legends, and formats.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation and installation of product.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

1.7 FIELD CONDITIONS

- A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

PART 2 PRODUCTS**2.1 IDENTIFICATION REQUIREMENTS**

- A. Existing Work: Unless specifically excluded, identify existing elements to remain that are not already identified in accordance with specified requirements.
- B. Identification for Equipment:
1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
 - a. Panelboards:
 - 1) Identify ampere rating.
 - 2) Identify voltage and phase.
 - 3) Identify power source and circuit number. Include location when not within sight of equipment.
 - 4) Identify main overcurrent protective device. Use identification label for panelboards with a door. For power distribution panelboards without a door, use identification nameplate.
 - 5) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces using pencil.
 - 6) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
 - b. Enclosed switches, circuit breakers, and motor controllers:
 - 1) Identify voltage and phase.
 - 2) Identify power source and circuit number. Include location when not within sight of equipment.
 - 3) Identify load(s) served. Include location when not within sight of equipment.
 - c. Enclosed Contactors:
 - 1) Identify ampere rating.
 - 2) Identify voltage and phase.
 - 3) Identify configuration, e.g., E.O.E.H. (electrically operated, electrically held) or E.O.M.H. (electrically operated, mechanically held).
 - 4) Identify coil voltage.
 - 5) Identify load(s) and associated circuits controlled. Include location.
 - d. Transfer Switches:
 - 1) Identify voltage and phase.
 - 2) Identify power source and circuit number for both normal power source and standby power source. Include location when not within sight of equipment.
 - 3) Identify load(s) served. Include location when not within sight of equipment.
 - 4) Identify short circuit current rating based on the specific overcurrent protective device type and settings protecting the transfer switch.
 2. Service Equipment:
 - a. Use identification nameplate to identify each service disconnecting means.

3. Emergency System Equipment:
 - a. Use identification nameplate or voltage marker to identify emergency system equipment in accordance with NFPA 70.
 - b. Use identification nameplate at each piece of service equipment to identify type and location of on-site emergency power sources.
 - c. Use identification nameplate to identify emergency operating instructions for emergency system equipment.
 4. Use voltage marker to identify highest voltage present for each piece of electrical equipment.
 5. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.
 6. Use identification label or handwritten text using indelible marker on inside of door at each motor controller to identify nameplate horsepower, full load amperes, code letter, service factor, voltage, and phase of motor(s) controlled.
 7. Use floor marking tape or warning labels to identify required equipment working clearances where indicated or where required by the authority having jurisdiction.
 8. Available Fault Current Documentation: Use identification label to identify the available fault current and date calculations were performed at locations requiring documentation by NFPA 70, including but not limited to the following. Consult Engineer for values and label for the main enclosed circuit breaker.
 - a. Service equipment.
 9. Use warning labels, identification nameplates, or identification labels to identify electrical hazards for equipment where multiple power sources are present with the word message "DANGER; Hazardous voltage; Multiple power sources may be present; Disconnect all electric power including remote disconnects before servicing" or approved equivalent.
- C. Identification for Conductors and Cables:
1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 05 19.
 2. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.
 3. Use wire and cable markers to identify circuit number or other designation indicated for power, control, and instrumentation conductors and cables at the following locations:
 - a. At each source and load connection.
 - b. Within boxes when more than one circuit is present.
 - c. Within equipment enclosures when conductors and cables enter or leave the enclosure.
 4. Use wire and cable markers to identify connected grounding electrode system components for grounding electrode conductors.
- D. Identification for Raceways:
1. Use underground warning tape to identify underground raceways.
- E. Identification for Boxes:
1. Use voltage markers to identify highest voltage present.
 2. Use voltage markers to identify systems other than normal power system.

2.2 IDENTIFICATION NAMEPLATES AND LABELS

- A. Identification Nameplates:
1. Manufacturers:
 - a. Brimar Industries, Inc: www.brimar.com.
 - b. Kolbi Pipe Marker Co: www.kolbipipemarkers.com.

- c. Seton Identification Products: www.seton.com.
 - 2. Materials:
 - a. Indoor Clean, Dry Locations: Use plastic nameplates.
 - b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.
 - 3. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.
 - 4. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.
 - 5. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text.
 - 6. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.
- B. Identification Labels:
- 1. Manufacturers:
 - a. Brady Corporation: www.bradyid.com.
 - b. Brother International Corporation: www.brother-usa.com.
 - c. Panduit Corp: www.panduit.com.
 - 2. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
 - 3. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.
- C. Format for Equipment Identification:
- 1. Minimum Size: 1 inch by 2.5 inches.
 - 2. Legend:
 - a. System designation where applicable:
 - 1) Emergency Power System: Identify with text "EMERGENCY".
 - b. Equipment designation or other approved description.
 - 3. Text: All capitalized unless otherwise indicated.
 - 4. Minimum Text Height:
 - a. System Designation: 1 inch.
 - b. Equipment Designation: 1/2 inch.
 - 5. Color:
 - a. Normal Power System: White text on black background.
 - b. Emergency Power System: White text on red background.
- D. Format for General Information and Operating Instructions:
- 1. Minimum Size: 1 inch by 2.5 inches.
 - 2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
 - 3. Text: All capitalized unless otherwise indicated.
 - 4. Minimum Text Height: 1/4 inch.
 - 5. Color: Black text on white background unless otherwise indicated.
 - a. Exceptions:
 - 1) Provide white text on red background for general information or operational instructions for emergency systems.
- E. Format for Caution and Warning Messages:
- 1. Minimum Size: 2 inches by 4 inches.
 - 2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
 - 3. Text: All capitalized unless otherwise indicated.

4. Minimum Text Height: 1/2 inch.
5. Color: Black text on yellow background unless otherwise indicated.

2.3 WIRE AND CABLE MARKERS

- A. Manufacturers:
 1. Brady Corporation: www.bradyid.com.
 2. HellermannTyton: www.hellermanntyton.com.
 3. Panduit Corp: www.panduit.com.
- B. Markers for Conductors and Cables: Use heat-shrink sleeve or plastic clip-on type markers suitable for the conductor or cable to be identified.
 1. Do not use self-adhesive type markers.
- C. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.
- D. Legend: Power source and circuit number or other designation indicated.
- E. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.
 1. Do not use handwritten text.
- F. Minimum Text Height: 1/8 inch.
- G. Color: Black text on white background unless otherwise indicated.

2.4 VOLTAGE MARKERS

- A. Manufacturers:
 1. Brady Corporation: www.bradyid.com.
 2. Brimar Industries, Inc: www.brimar.com.
 3. Seton Identification Products: www.seton.com.
- B. Markers for Boxes and Equipment Enclosures: Use factory pre-printed self-adhesive vinyl or self-adhesive vinyl cloth type markers.
- C. Minimum Size:
 1. Markers for Equipment: 1 1/8 by 4 1/2 inches.
 2. Markers for Pull Boxes: 1 1/8 by 4 1/2 inches.
 3. Markers for Junction Boxes: 1/2 by 2 1/4 inches.
- D. Legend:
 1. Markers for Voltage Identification: Highest voltage present.
 2. Markers for System Identification:
 - a. Emergency Power System: Text "EMERGENCY".
- E. Color: Black text on orange background unless otherwise indicated.

2.5 UNDERGROUND WARNING TAPE

- A. Manufacturers:
 1. Brady Corporation: www.bradyid.com.
 2. Brimar Industries, Inc: www.brimar.com.
 3. Seton Identification Products: www.seton.com.
- B. Materials: Use foil-backed detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.

- C. Foil-backed Detectable Type Tape: 3 inches wide, with minimum thickness of 5 mil, unless otherwise required for proper detection.
- D. Legend: Type of service, continuously repeated over full length of tape.
- E. Color:
 - 1. Tape for Buried Power Lines: Black text on red background.

2.6 FLOOR MARKING TAPE

- A. Manufacturers:
 - 1. Brady Corporation: www.bradyid.com.
 - 2. Brimar Industries, Inc: www.brimar.com.
 - 3. Seton Identification Products: www.seton.com.
- B. Floor Marking Tape for Equipment Working Clearance Identification: Self-adhesive vinyl or polyester tape with overlamine, 3 inches wide, with alternating black and white stripes.

2.7 WARNING SIGNS AND LABELS

- A. Manufacturers:
 - 1. Brimar Industries, Inc: www.brimar.com.
 - 2. Clarion Safety Systems, LLC: www.clarionsafety.com.
 - 3. Seton Identification Products: www.seton.com.
- B. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.
- C. Warning Signs:
 - 1. Materials:
 - a. Indoor Dry, Clean Locations: Use factory pre-printed rigid plastic or self-adhesive vinyl signs.
 - b. Outdoor Locations: Use factory pre-printed rigid aluminum signs.
 - 2. Rigid Signs: Provide four mounting holes at corners for mechanical fasteners.
 - 3. Minimum Size: 7 by 10 inches unless otherwise indicated.
- D. Warning Labels:
 - 1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
 - a. Do not use labels designed to be completed using handwritten text.
 - 2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
 - 3. Minimum Size: 2 by 4 inches unless otherwise indicated.

PART 3 EXECUTION

3.1 PREPARATION

- A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:

1. Surface-Mounted Equipment: Enclosure front.
 2. Flush-Mounted Equipment: Inside of equipment door.
 3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
 4. Elevated Equipment: Legible from the floor or working platform.
 5. Branch Devices: Adjacent to device.
 6. Interior Components: Legible from the point of access.
 7. Conduits: Legible from the floor.
 8. Boxes: Outside face of cover.
 9. Conductors and Cables: Legible from the point of access.
- C. Install identification products centered, level, and parallel with lines of item being identified.
- D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.
1. Do not use adhesives on exterior surfaces except where substrate cannot be penetrated.
- E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.
- F. Install underground warning tape above buried lines with one tape per trench at 3 inches below finished grade.
- G. Secure rigid signs using stainless steel screws.
- H. Mark all handwritten text, where permitted, to be neat and legible.

3.3 FIELD QUALITY CONTROL

- A. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

END OF SECTION 26 05 53

SECTION 26 05 83**WIRING CONNECTIONS****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Electrical connections to equipment.

1.2 RELATED REQUIREMENTS

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
- B. Section 26 05 33.13 - Conduit for Electrical Systems.
- C. Section 26 05 33.16 - Boxes for Electrical Systems.
- D. Section 26 27 26 - Wiring Devices.

1.3 REFERENCE STANDARDS

- A. NEMA WD 1 - General Color Requirements for Wiring Devices; 1999 (R 2010).
- B. NEMA WD 6 - Wiring Devices - Dimensional Specifications; 2012.
- C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
 - 2. Determine connection locations and requirements.
- B. Sequencing:
 - 1. Install rough-in of electrical connections before installation of equipment is required.
 - 2. Make electrical connections before required start-up of equipment.

PART 2 PRODUCTS**2.1 MATERIALS**

- A. Cords and Caps: NEMA WD 6; match receptacle configuration at outlet provided for equipment.
 - 1. Colors: Comply with NEMA WD 1.
 - 2. Cord Construction: NFPA 70, Type SO, multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.
 - 3. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.
- B. Wiring Devices: As specified in Section 26 27 26.
- C. Flexible Conduit: As specified in Section 26 05 33.13.
- D. Wire and Cable: As specified in Section 26 05 19.
- E. Boxes: As specified in Section 26 05 33.16.

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2.2 EQUIPMENT CONNECTIONS

- A. Unless otherwise indicated, all equipment shall be powered with directly connected conductors in conduit.

PART 3 EXECUTION**3.1 EXAMINATION**

- A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.2 ELECTRICAL CONNECTIONS

- A. Make electrical connections in accordance with equipment manufacturer's instructions.
- B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.
- C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.
- D. Provide receptacle outlet to accommodate connection with attachment plug.
- E. Provide cord and cap where field-supplied attachment plug is required.
- F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.
- H. Install terminal block jumpers to complete equipment wiring requirements.
- I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

END OF SECTION 26 05 83

SECTION 26 21 00**LOW-VOLTAGE ELECTRICAL SERVICE ENTRANCE****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Electrical service requirements.

1.2 RELATED REQUIREMENTS

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.3 DEFINITIONS

- A. Service Point: The point of connection between the facilities of the serving utility and the premises wiring as defined in NFPA 70, and as designated by the Utility Company.

1.4 REFERENCE STANDARDS

- A. IEEE C2 - National Electrical Safety Code; 2012.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.5 ADMINISTRATIVE REQUIREMENTS

- A. No later than two weeks following date of the Agreement, notify Utility Company of anticipated date of service.
- B. Coordination:
 - 1. Verify the following with Utility Company representative:
 - a. Utility Company requirements, including division of responsibility.
 - b. Exact location and details of utility point of connection.
 - c. Utility easement requirements.
 - d. Utility Company charges associated with providing service.
 - 2. Coordinate the work with other trades to avoid placement of other utilities or obstructions within the spaces dedicated for electrical service and associated equipment.
 - 3. Coordinate arrangement of service entrance equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 4. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- C. Arrange for Utility Company to provide permanent electrical service. Prepare and submit documentation required by Utility Company.
- D. Utility Company charges associated with providing permanent service to be paid by Owner.
- E. Preinstallation Meeting: Convene one week prior to commencing work of this section to review service requirements and details with Utility Company representative.

- F. Scheduling:
1. Where work of this section involves interruption of existing electrical service, arrange service interruption with Owner.
 2. Arrange for inspections necessary to obtain Utility Company approval of installation.

1.6 QUALITY ASSURANCE

- A. Comply with the following:
1. IEEE C2 (National Electrical Safety Code).
 2. NFPA 70 (National Electrical Code).
 3. The requirements of the Utility Company.

PART 2 PRODUCTS

2.1 ELECTRICAL SERVICE REQUIREMENTS

- A. Provide new electrical service consisting of all required conduits, conductors, equipment, metering provisions, supports, accessories, etc. as necessary for connection between Utility Company point of supply and service entrance equipment.
- B. Electrical Service Characteristics: As indicated on drawings.
- C. Utility Company: Met-Ed.
1. Point of Contact: Ryan Lenich.
 2. Phone: 610-921-6753.
 3. Utility Company Project Reference Number: TBD.
- D. Division of Responsibility:
1. Existing Underground Service Vault:
 - a. Secondary - Underground Service:
 - 1) Conduits: Furnished and installed by Contractor (Service Point underground at street curb).
 - 2) Conductors: Furnished and installed by Utility Company.
 2. Terminations at Service Point: Provided by Utility Company.
 3. Metering Provisions:
 - a. Meter Bases: Furnished and installed by Contractor per Utility Company requirements.
- E. Products Furnished by Contractor: Comply with Utility Company requirements.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that ratings and configurations of service entrance equipment are consistent with the indicated requirements.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

- A. Verify and mark locations of existing underground utilities.
- B. Coordinate all work and details with Utility Company before proceeding with installation of duct bank, conductors, and service equipment.

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3.3 INSTALLATION

- A. Install products in accordance with manufacturer's instructions and Utility Company requirements.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Arrange equipment to provide minimum clearances and required maintenance access.
- D. Provide required support and attachment components in accordance with Section 26 05 29.
- E. Provide grounding and bonding for service entrance equipment in accordance with Section 26 05 26.
- F. Identify service entrance equipment, including main service disconnect(s) in accordance with Section 26 05 53.

3.4 PROTECTION

- A. Protect installed equipment from subsequent construction operations.

END OF SECTION 26 21 00

SECTION 26 24 16**PANELBOARDS****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Power distribution panelboards.
- B. Lighting and appliance panelboards.
- C. Overcurrent protective devices for panelboards.

1.2 RELATED REQUIREMENTS

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.3 REFERENCE STANDARDS

- A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; Federal Specification; Revision E, 2013.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- C. NECA 407 - Standard for Installing and Maintaining Panelboards; 2009.
- D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
- E. NEMA PB 1 - Panelboards; 2011.
- F. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less; 2013.
- G. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2013.
- H. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- I. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- J. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- K. UL 67 - Panelboards; Current Edition, Including All Revisions.
- L. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.
- M. UL 869A - Reference Standard for Service Equipment; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted panelboards where indicated.
4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
5. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.
 1. Include characteristic trip curves for each type and rating of overcurrent protective device upon request.
- B. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
 1. Include dimensioned plan and elevation views of panelboards and adjacent equipment with all required clearances indicated.
 2. Include wiring diagrams showing all factory and field connections.
- C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- D. Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.
- E. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.
- F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 1. Panelboard Keys: Two of each different key.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store panelboards in accordance with manufacturer's instructions and NECA 407.
- B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

- C. Handle carefully in accordance with manufacturer's written instructions to avoid damage to panelboard internal components, enclosure, and finish.

1.8 FIELD CONDITIONS

- A. Maintain ambient temperature within the following limits during and after installation of panelboards:
 - 1. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Eaton Corporation: www.eaton.com.
- B. Schneider Electric; Square D Products: www.schneider-electric.us.
- C. Siemens Industry, Inc: www.usa.siemens.com.
- D. Source Limitations: Furnish panelboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.2 PANELBOARDS - GENERAL REQUIREMENTS

- A. Provide products listed, classified, and labeled as suitable for the purpose intended.
- B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
 - 1. Altitude: Less than 6,600 feet.
 - 2. Ambient Temperature:
 - a. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.
- C. Short Circuit Current Rating:
 - 1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
- D. Panelboards Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.
- E. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.
- F. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.
- G. Bussing: Sized in accordance with UL 67 temperature rise requirements.
 - 1. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
 - 2. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
- H. Conductor Terminations: Suitable for use with the conductors to be installed.
- I. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
 - 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
 - 2. Boxes: Galvanized steel unless otherwise indicated.

- a. Provide wiring gutters sized to accommodate the conductors to be installed.
 - b. Provide removable end walls for NEMA Type 1 enclosures.
 - c. Provide painted steel boxes for surface-mounted panelboards located in the apparatus bays, finish to match fronts.
- 3. Fronts:
 - a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.
 - b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.
 - c. Finish for Painted Steel Fronts: Manufacturer's standard grey unless otherwise indicated.
- 4. Lockable Doors: All locks keyed alike unless otherwise indicated.
- J. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.
- K. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.
- L. Load centers are not acceptable.

2.3 POWER DISTRIBUTION PANELBOARDS

- A. Description: Panelboards complying with NEMA PB 1, power and feeder distribution type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.
- B. Conductor Terminations:
 - 1. Main and Neutral Lug Material: Copper, suitable for terminating copper conductors only.
 - 2. Main and Neutral Lug Type: Mechanical.
- C. Bussing:
 - 1. Phase and Neutral Bus Material: Copper.
 - 2. Ground Bus Material: Copper.
- D. Circuit Breakers:
 - 1. Provide bolt-on type or plug-in type secured with locking mechanical restraints.
 - 2. Provide thermal magnetic circuit breakers unless otherwise indicated.
 - 3. Provide electronic trip circuit breakers where indicated.
- E. Enclosures:
 - 1. Provide surface-mounted enclosures unless otherwise indicated.
 - 2. Fronts: Provide lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
 - 3. Provide clear plastic circuit directory holder mounted on inside of door.

2.4 LIGHTING AND APPLIANCE PANELBOARDS

- A. Description: Panelboards complying with NEMA PB 1, lighting and appliance branch circuit type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.
- B. Conductor Terminations:
 - 1. Main and Neutral Lug Material: Copper, suitable for terminating copper conductors only.
 - 2. Main and Neutral Lug Type: Mechanical.
- C. Bussing:
 - 1. Phase Bus Connections: Arranged for sequential phasing of overcurrent protective devices.

2. Phase and Neutral Bus Material: Copper.
 3. Ground Bus Material: Copper.
- D. Circuit Breakers: Thermal magnetic bolt-on type unless otherwise indicated.
- E. Enclosures:
1. Provide surface-mounted or flush-mounted enclosures as indicated.
 2. Fronts: Provide door-in-door trim with hinged cover for access to load terminals and wiring gutters, and separate lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
 3. Provide clear plastic circuit directory holder mounted on inside of door.

2.5 OVERCURRENT PROTECTIVE DEVICES

- A. Molded Case Circuit Breakers:
1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
 2. Interrupting Capacity:
 - a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
 - 1) 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.
 - b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
 3. Conductor Terminations:
 - a. Provide mechanical lugs unless otherwise indicated.
 - b. Provide compression lugs where indicated.
 - c. Lug Material: Copper, suitable for terminating copper conductors only.
 4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
 - a. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
 5. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
 - a. Provide the following field-adjustable trip response settings:
 - 1) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
 - 2) Long time delay.
 - 3) Short time pickup and delay.
 - 4) Instantaneous pickup.
 - 5) Ground fault pickup and delay where ground fault protection is indicated.
 - b. Provide zone selective interlocking capability where indicated, capable of communicating with other electronic trip circuit breakers and external ground fault sensing systems to control short time delay and ground fault delay functions for system coordination purposes.
 6. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
 7. Do not use tandem circuit breakers.
 8. Do not use handle ties in lieu of multi-pole circuit breakers.
 9. Provide multi-pole circuit breakers for multi-wire branch circuits as required by NFPA 70.

2.6 SOURCE QUALITY CONTROL

- A. Factory test panelboards according to NEMA PB 1.

PART 3 EXECUTION**3.1 EXAMINATION**

- A. Verify that field measurements are as indicated.
- B. Verify that the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive panelboards.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship).
- B. Install products in accordance with manufacturer's instructions.
- C. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.
- D. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- E. Provide required support and attachment in accordance with Section 26 05 29.
- F. Install panelboards plumb.
- G. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.
- H. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches above the floor or working platform.
- I. Provide minimum of six spare 1 inch trade size conduits out of each flush-mounted panelboard stubbed into accessible space above ceiling and below floor.
- J. Provide grounding and bonding in accordance with Section 26 05 26.
- K. Install all field-installed branch devices, components, and accessories.
- L. Set field-adjustable circuit breaker tripping function settings as indicated.
- M. Provide filler plates to cover unused spaces in panelboards.
- N. Provide circuit breaker lock-on devices to prevent unauthorized personnel from de-energizing essential loads where indicated. Also provide for the following:
 - 1. Emergency and night lighting circuits.
 - 2. Fire detection and alarm circuits.
- O. Identify panelboards in accordance with Section 26 05 53.
- P. Provide sheet metal fillers where panels are installed within or adjacent to existing panelboard back boxes designated for replacement as indicated on the Drawings.

3.3 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS, except Section 4.

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- B. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for all main circuit breakers and circuit breakers larger than 100 amperes. Tests listed as optional are not required.
- C. Correct deficiencies and replace damaged or defective panelboards or associated components.

3.4 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
- B. Adjust alignment of panelboard fronts.
- C. Load Balancing: For each panelboard, rearrange circuits such that the difference between each measured steady state phase load does not exceed 20 percent and adjust circuit directories accordingly. Maintain proper phasing for multi-wire branch circuits.

3.5 CLEANING

- A. Clean dirt and debris from panelboard enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 26 24 16

SECTION 26 27 26**WIRING DEVICES****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Receptacles.
- B. Wall plates.

1.2 RELATED REQUIREMENTS

- A. Section 26 05 33.16 - Boxes for Electrical Systems.

1.3 REFERENCE STANDARDS

- A. FS W-C-596 - Connector, Electrical, Power, General Specification for; Federal Specification; Revision G, 2001.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- C. NEMA WD 1 - General Color Requirements for Wiring Devices; 1999 (R 2010).
- D. NEMA WD 6 - Wiring Devices - Dimensional Specifications; 2012.
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. UL 498 - Attachment Plugs and Receptacles; Current Edition, Including All Revisions.
- G. UL 514D - Cover Plates for Flush-Mounted Wiring Devices; Current Edition, Including All Revisions.
- H. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the placement of outlet boxes with millwork, furniture, equipment, etc. installed under other sections or by others.
 - 2. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed.
 - 3. Coordinate the installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.
 - 4. Notify Engineer of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.
- B. Sequencing:
 - 1. Do not install wiring devices until final surface finishes and painting are complete.

1.5 SUBMITTALS

- A. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.
- B. Field Quality Control Test Reports.

- C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- D. Operation and Maintenance Data:
 - 1. GFCI Receptacles: Include information on status indicators.
- E. Project Record Documents: Record actual installed locations of wiring devices.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Products: Listed, classified, and labeled as suitable for the purpose intended.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND PROTECTION

- A. Store in a clean, dry space in original manufacturer's packaging until ready for installation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Hubbell Incorporated: www.hubbell-wiring.com.
- B. Leviton Manufacturing Company, Inc: www.leviton.com.
- C. Lutron Electronics Company, Inc: www.lutron.com.
- D. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us

2.2 WIRING DEVICE APPLICATIONS

- A. Provide wiring devices suitable for intended use and with ratings adequate for load served.
- B. Provide GFCI protection for receptacles serving electric drinking fountains.

2.3 WIRING DEVICE FINISHES

- A. Provide wiring device finishes as described below unless otherwise indicated.
- B. Wiring Devices Installed in Finished Spaces: White with white nylon wall plate.

2.4 RECEPTACLES

- A. Manufacturers:
 - 1. Hubbell Incorporated: www.hubbell-wiring.com.
 - 2. Leviton Manufacturing Company, Inc: www.leviton.com.
 - 3. Lutron Electronics Company, Inc: www.lutron.com.
 - 4. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us

- B. Receptacles - General Requirements: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498, and where applicable, FS W-C-596; types as indicated on the drawings.
 - 1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.
 - 2. NEMA configurations specified are according to NEMA WD 6.
- C. GFCI Receptacles:
 - 1. GFCI Receptacles - General Requirements: Self-testing, with feed-through protection and light to indicate ground fault tripped condition and loss of protection; listed as complying with UL 943, class A.
 - a. Provide test and reset buttons of same color as device.
 - 2. Standard GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style.

2.5 WALL PLATES

- A. Manufacturers:
 - 1. Hubbell Incorporated: www.hubbell-wiring.com.
 - 2. Leviton Manufacturing Company, Inc: www.leviton.com.
 - 3. Lutron Electronics Company, Inc: www.lutron.com.
 - 4. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us.
- B. Wall Plates: Comply with UL 514D.
 - 1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
 - 2. Size: Standard.
 - 3. Screws: Metal with slotted heads finished to match wall plate finish.
- C. Nylon Wall Plates: Smooth finish, high-impact thermoplastic.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.
- C. Verify that wall openings are neatly cut and will be completely covered by wall plates.
- D. Verify that final surface finishes are complete, including painting.
- E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.
- F. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

- A. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130.
- B. Coordinate locations of outlet boxes provided under Section 26 05 33.16 as required for installation of wiring devices provided under this section.
 - 1. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
- C. Install wiring devices in accordance with manufacturer's instructions.
- D. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- E. Where required, connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals.
- F. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.
- G. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
- H. Provide GFCI receptacles with integral GFCI protection at each location indicated. Do not use feed-through wiring to protect downstream devices.
- I. Install wiring devices plumb and level with mounting yoke held rigidly in place.
- J. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.
- K. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
- L. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.

3.4 FIELD QUALITY CONTROL

- A. Inspect each wiring device for damage and defects.
- B. Test each receptacle to verify operation and proper polarity.
- C. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.
- D. Correct wiring deficiencies and replace damaged or defective wiring devices.

3.5 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.

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3.6 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

END OF SECTION 26 27 26

SECTION 26 28 16.13**ENCLOSED CIRCUIT BREAKERS****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Enclosed circuit breakers.

1.2 RELATED REQUIREMENTS

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.3 REFERENCE STANDARDS

- A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; Federal Specification; Revision E, 2013.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
- D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2013.
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- G. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- H. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.
- I. UL 869A - Reference Standard for Service Equipment; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within dedicated equipment spaces and within working clearances for electrical equipment required by NFPA 70.
 - 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
 - 4. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for circuit breakers, enclosures, and other installed components and accessories.
 - 1. Include characteristic trip curves for each type and rating of circuit breaker upon request.
- B. Shop Drawings: Indicate outline and support point dimensions, voltage and current ratings, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
 - 1. Include dimensioned plan and elevation views of enclosed circuit breakers and adjacent equipment with all required clearances indicated.
 - 2. Include wiring diagrams showing all factory and field connections.
- C. Field Quality Control Test Reports.
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- E. Project Record Documents: Record actual installed locations of enclosed circuit breakers.
- F. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed circuit breaker internal components, enclosure, and finish.

1.8 FIELD CONDITIONS

- A. Maintain ambient temperature between 23 degrees F and 104 degrees F during and after installation of enclosed circuit breakers.

PART 2 PRODUCTS**2.1 MANUFACTURERS**

- A. Eaton Corporation: www.eaton.com.
- B. Schneider Electric; Square D Products: www.schneider-electric.us.
- C. Siemens Industry, Inc: www.usa.siemens.com.

- D. Source Limitations: Furnish enclosed circuit breakers and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.2 ENCLOSED CIRCUIT BREAKERS

- A. Description: Units consisting of molded case circuit breakers individually mounted in enclosures.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
1. Altitude: Less than 6,600 feet.
 2. Ambient Temperature: Between 23 degrees F and 104 degrees F.
- D. Short Circuit Current Rating:
1. Provide enclosed circuit breakers with listed short circuit current rating as indicated on the drawings.
- E. Enclosed Circuit Breakers Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.
- F. Conductor Terminations: Suitable for use with the conductors to be installed.
- G. Provide thermal magnetic circuit breakers unless otherwise indicated.
- H. Provide electronic trip circuit breakers where indicated.
- I. Provide insulated, groundable fully rated solid neutral assembly where a neutral connection is required, with a suitable lug for terminating each neutral conductor.
- J. Provide solidly bonded equipment ground bus in each enclosed circuit breaker, with a suitable lug for terminating each equipment grounding conductor.
- K. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
 2. Finish for Painted Steel Enclosures: Manufacturer's standard, factory applied grey unless otherwise indicated.
 3. Provide surface-mounted enclosures unless otherwise indicated.
- L. Provide externally operable handle with means for locking in the OFF position.
- M. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.

2.3 MOLDED CASE CIRCUIT BREAKERS

- A. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
- B. Interrupting Capacity:
1. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:

- a. 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.
2. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
- C. Conductor Terminations:
 1. Provide mechanical lugs unless otherwise indicated.
 2. Provide compression lugs where indicated.
 3. Lug Material: Copper, suitable for terminating copper conductors only.
- D. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
 1. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
 2. Provide interchangeable trip units where indicated.
- E. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
 1. Provide the following field-adjustable trip response settings:
 - a. Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
 - b. Long time delay.
 - c. Short time pickup and delay.
 - d. Instantaneous pickup.
 2. Provide zone selective interlocking capability where indicated, capable of communicating with other electronic trip circuit breakers and external ground fault sensing systems to control short time delay and ground fault delay functions for system coordination purposes.
- F. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that the ratings of the enclosed circuit breakers are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive enclosed circuit breakers.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide required support and attachment in accordance with Section 26 05 29.
- E. Install enclosed circuit breakers plumb.
- F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed circuit breakers such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.
- G. Provide grounding and bonding in accordance with Section 26 05 26.

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- H. Set field-adjustable circuit breaker tripping function settings as indicated.
- I. Identify enclosed circuit breakers in accordance with Section 26 05 53.

3.3 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with manufacturer's instructions and NETA ATS, except Section 4.
- B. Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for circuit breakers used for service entrance and for circuit breakers larger than 100 amperes. Tests listed as optional are not required.
- C. Correct deficiencies and replace damaged or defective enclosed circuit breakers.

3.4 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.5 CLEANING

- A. Clean dirt and debris from circuit breaker enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 26 28 16.13

SECTION 26 29 13**ENCLOSED CONTROLLERS****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Enclosed NEMA controllers for low-voltage (600 V and less) applications:
 - 1. Magnetic motor starters.
 - 2. Manual motor starters.
- B. Overcurrent protective devices for motor controllers, including overload relays.
- C. Control accessories:
 - 1. Auxiliary contacts.
 - 2. Pilot devices.
 - 3. Control and timing relays.
 - 4. Control power transformers.
 - 5. Control terminal blocks.

1.2 RELATED REQUIREMENTS

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Section 26 05 29 - Hangers and Supports for Electrical Systems.

1.3 REFERENCE STANDARDS

- A. IEEE C57.13 - IEEE Standard Requirements for Instrument Transformers; 2008.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
- D. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts; 2000 (R2005), with errata, 2008.
- E. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices; 2000 (R2010).
- F. NEMA ICS 6 - Industrial Control and Systems: Enclosures; 1993 (R2011).
- G. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2013.
- H. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- I. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.
- J. UL 60947-1 - Low-Voltage Switchgear and Controlgear - Part 1: General Rules; Current Edition, Including All Revisions.
- K. UL 60947-4-1 - Low-Voltage Switchgear and Controlgear - Part 4-1: Contractors and Motor-starters - Electromechanical Contractors and Motor-starters; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.
 2. Coordinate the work to provide motor controllers and associated overload relays suitable for use with the actual motors to be installed.
 3. Coordinate the work to provide controllers and associated wiring suitable for interface with control devices to be installed.
 4. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 5. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
 6. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for motor controllers, enclosures, overcurrent protective devices, and other installed components and accessories.
1. Include characteristic trip curves for each type and rating of overcurrent protective device upon request.
- B. Shop Drawings: Indicate dimensions, voltage, controller sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
1. Include dimensioned plan and elevation views of enclosed controllers and adjacent equipment with all required clearances indicated.
 2. Include wiring diagrams showing all factory and field connections.
 3. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
- C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- D. Field Quality Control Test Reports.
- E. Project Record Documents: Record actual installed locations of controllers and final equipment settings.
1. Include nameplate data of actual installed motors and associated overload relay selections and settings.
 2. Motor Circuit Protectors: Include magnetic instantaneous trip settings.
- F. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to internal components, enclosure, and finish.

1.8 FIELD CONDITIONS

- A. Maintain field conditions within required service conditions during and after installation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Eaton Corporation: www.eaton.com.
- B. Rockwell Automation, Inc; Allen-Bradley Products: ab.rockwellautomation.com.
- C. Schneider Electric; Square D Products: www.schneider-electric.us.
- D. Siemens Industry, Inc: www.usa.siemens.com.
- E. Source Limitations: Furnish enclosed motor controllers and associated components produced by a single manufacturer and obtained from a single supplier.

2.2 ENCLOSED CONTROLLERS

- A. Provide enclosed controller assemblies consisting of all required components, control power transformers, instrumentation and control wiring, accessories, etc. as necessary for a complete operating system.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Description: Enclosed controllers complying with NEMA ICS 2, and listed and labeled as complying with UL 60947-1 and UL 60947-4-1; ratings, configurations and features as indicated on the drawings.
- D. Service Conditions:
1. Provide controllers and associated components suitable for operation under the following service conditions without derating:
 - a. Altitude:
 - 1) Class 1 Km Equipment (devices utilizing power semiconductors, e.g. variable frequency controllers): Less than 3,300 feet.
 - 2) Class 2 Km Equipment (electromagnetic and manual devices): Less than 6,600 feet.
 - b. Ambient Temperature: Between 32 degrees F and 104 degrees F.
 2. Provide controllers and associated components suitable for operation at indicated ratings under the service conditions at the installed location.
- E. Short Circuit Current Rating:
1. Provide controllers with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
- F. Conductor Terminations: Suitable for use with the conductors to be installed.

- G. Enclosures:
1. Comply with NEMA ICS 6.
 2. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1 or Type 12.
 - b. Outdoor Locations: Type 3R or Type 4.
 3. Finish: Manufacturer's standard unless otherwise indicated.
- H. Instrument Transformers:
1. Comply with IEEE C57.13.
 2. Select suitable ratio, burden, and accuracy as required for connected devices.
 3. Current Transformers: Connect secondaries to shorting terminal blocks.
 4. Potential Transformers: Include primary and secondary fuses with disconnecting means.
- I. Magnetic Motor Starters: Combination type unless otherwise indicated.
1. Combination Magnetic Motor Starters: NEMA ICS 2, Class A combination motor controllers with magnetic contactor(s), externally operable disconnect and overload relay(s).
 2. Configuration: Full-voltage non-reversing unless otherwise indicated.
 3. Minimum Starter Size: NEMA Size 1.
 4. Disconnects: Circuit breaker type.
 - a. Circuit Breakers: Motor circuit protectors (magnetic-only) unless otherwise indicated or required.
 - b. Provide externally operable handle with means for locking in the OFF position. Provide safety interlock to prevent opening the cover with the disconnect in the ON position with capability of overriding interlock for testing purposes.
 - c. Provide auxiliary interlock for disconnection of external control power sources where applicable.
 5. Overload Relays: Bimetallic thermal type unless otherwise indicated.
 6. Pilot Devices Required:
 - a. Furnish local pilot devices for each unit as specified below unless otherwise indicated on drawings.
 - b. Single-Speed, Non-Reversing Starters:
 - 1) Selector Switches: HAND/OFF/AUTO.
 - 2) Indicating Lights: Red ON, Green OFF.
- J. Manual Motor Starters:
1. Description: NEMA ICS 2, Class A manually-operated motor controllers with overload relay(s).
 2. Configuration: Non-reversing unless otherwise indicated.
 3. Fractional-Horsepower Manual Motor Starters:
 - a. Furnish with toggle operator.
 - b. Overload Relays: Bimetallic or melting alloy thermal type.
 - c. Provide means for locking operator in the OFF position.
 4. Integral-Horsepower Manual Motor Starters:
 - a. Furnish with toggle or pushbutton operator.
 - b. Overload Relays: Bimetallic or melting alloy thermal type.

2.3 OVERCURRENT PROTECTIVE DEVICES

- A. Overload Relays:
1. Provide overload relays and, where applicable, associated current elements/heaters, selected according to actual installed motor nameplate data, in accordance with manufacturer's

- recommendations and NFPA 70; include consideration for motor service factor and ambient temperature correction, where applicable.
2. Inverse-Time Trip Class Rating: Class 20 unless otherwise indicated or required.
 3. Trip-free operation.
 4. Visible trip indication.
 5. Resettable.
 - a. Employ manual reset unless otherwise indicated.
 - b. Do not employ automatic reset with two-wire control.
 6. Bimetallic Thermal Overload Relays:
 - a. Provide ambient temperature compensation.
 - b. Interchangeable current elements/heaters.
 - c. Adjustable trip; plus/minus 10 percent of nominal, minimum.
 - d. Trip test function.
 7. Melting Alloy Thermal Overload Relays:
 - a. Interchangeable current elements/heaters.
- B. Circuit Breakers:
1. Interrupting Capacity (not applicable to motor circuit protectors):
 - a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than specified minimum requirements.
 - b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
 2. Motor Circuit Protectors:
 - a. Description: Instantaneous-trip circuit breakers furnished with magnetic instantaneous tripping elements for short circuit protection, but not with thermal inverse time tripping elements for overload protection; UL 489 recognized only for use as part of a listed combination motor controller with overload protection; ratings, configurations, and features as indicated on the drawings.
 - b. Provide field-adjustable magnetic instantaneous trip setting.

2.4 CONTROL ACCESSORIES

- A. Auxiliary Contacts:
1. Comply with NEMA ICS 5.
 2. Provide number and type of contacts indicated or required to perform necessary functions, including holding (seal-in) circuit and interlocking, plus one normally open (NO) and one normally closed (NC) spare contact for each magnetic motor starter, minimum.
- B. Pilot Devices:
1. Comply with NEMA ICS 5; heavy-duty type.
 2. Nominal Size: 30 mm.
 3. Pushbuttons: Unless otherwise indicated, provide momentary, non-illuminated type with flush button operator; normally open or normally closed as indicated or as required.
 4. Selector Switches: Unless otherwise indicated, provide maintained, non-illuminated type with knob operator; number of switch positions as indicated or as required.
 5. Indicating Lights: Push-to-test type unless otherwise indicated.
 6. Provide LED lamp source for indicating lights and illuminated devices.
- C. Control and Timing Relays:
1. Comply with NEMA ICS 5.
 2. Provide number and type of relays indicated or required to perform necessary functions.
- D. Control Power Transformers:

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1. Size to accommodate burden of contactor coil(s) and all connected auxiliary devices, plus 50 VA spare capacity.
 2. Include primary and secondary fuses.
- E. Control Terminal Blocks: Include 25 percent spare terminals.

PART 3 EXECUTION**3.1 EXAMINATION**

- A. Verify that field measurements are as indicated.
- B. Verify that ratings of enclosed controllers are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive enclosed controllers.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install controllers in accordance with NECA 1 (general workmanship).
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide required support and attachment in accordance with Section 26 05 29.
- E. Install enclosed controllers plumb and level.
- F. Provide grounding and bonding in accordance with Section 26 05 26.
- G. Install all field-installed devices, components, and accessories.
- H. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.
- I. Set field-adjustable controllers and associated components according to installed motor requirements, in accordance with manufacturer's recommendations and NFPA 70.
- J. Set field-adjustable circuit breaker tripping function settings as indicated.

3.3 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS, except Section 4.
- B. Motor Starters: Perform inspections and tests listed in NETA ATS, Section 7.16.1.1. Tests listed as optional are not required.
- C. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1. Tests listed as optional are not required.
- D. Correct deficiencies and replace damaged or defective enclosed controllers or associated components.
- E. Submit detailed reports indicating inspection and testing results and corrective actions taken.

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3.4 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.5 CLEANING

- A. Clean dirt and debris from controller enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

3.6 CLOSEOUT ACTIVITIES

- A. Demonstration: Demonstrate proper operation of controllers to Owner, and correct deficiencies or make adjustments as directed.
- B. Training: Train Owner's personnel on operation, adjustment, and maintenance of enclosed controllers and associated devices.
 - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 - 2. Provide minimum of two hours of training.
 - 3. Instructor: Manufacturer's authorized representative.
 - 4. Location: At project site.

3.7 PROTECTION

- A. Protect installed enclosed controllers from subsequent construction operations.

END OF SECTION 26 29 13

SECTION 26 32 13**ENGINE GENERATORS****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Packaged engine generator system and associated components and accessories:
 - 1. Engine and engine accessory equipment.
 - 2. Alternator (generator).
 - 3. Generator set control system.
 - 4. Generator set enclosure.

1.2 RELATED REQUIREMENTS

- A. Section 03 30 53 - Concrete for Utility Construction
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- C. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 26 36 00 - Transfer Switches.

1.3 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- B. NECA/EGSA 404 - Standard for Installing Generator Sets; 2014.
- C. NEMA MG 1 - Motors and Generators; 2014.
- D. NFPA 37 - Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines; 2015.
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. NFPA 99 - Health Care Facilities Code; 2015.
- G. NFPA 110 - Standard for Emergency and Standby Power Systems; 2013.
- H. UL 1236 - Battery Chargers for Charging Engine-Starter Batteries; Current Edition, Including All Revisions.
- I. UL 2200 - Stationary Engine Generator Assemblies; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate compatibility of generator sets to be installed with work provided under other sections or by others.
 - a. Transfer Switches: See Section 26 36 00.
 - 2. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment or other potential obstructions within the spaces dedicated for engine generator system.

3. Coordinate arrangement of equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 4. Coordinate the work to provide electrical circuits suitable for the power requirements of the actual auxiliary equipment and accessories to be installed.
 5. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Preinstallation Meeting: Convene one week before starting work of this section; require attendance of all affected installers.

1.5 **SUBMITTALS**

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product, including ratings, configurations, dimensions, finishes, weights, service condition requirements, and installed features. Include alternator starting capabilities, engine fuel consumption rates, and cooling, combustion air, and exhaust requirements.
 1. Include generator set sound level test data.
 2. Include characteristic trip curves for overcurrent protective devices upon request.
 3. Include alternator thermal damage curve upon request.
- B. Shop Drawings: Include dimensioned plan views and sections indicating locations of system components, required clearances, and field connection locations. Include system interconnection schematic diagrams showing all factory and field connections.
- C. Derating Calculations: Indicate ratings adjusted for applicable service conditions.
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.
- E. Manufacturer's factory emissions certification.
- F. Manufacturer's certification that products meet or exceed specified requirements.
- G. Source quality control test reports.
- H. Provide NFPA 110 required documentation from manufacturer where requested by authorities having jurisdiction, including but not limited to:
 1. Certified prototype tests.
 2. Torsional vibration compatibility certification.
 3. NFPA 110 compliance certification.
 4. Certified rated load test at rated power factor.
- I. Manufacturer's detailed field testing procedures.
- J. Field quality control test reports.
- K. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
- L. Executed Warranty: Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.
- M. Project Record Documents: Record actual locations of system components, installed circuiting arrangements and routing, and final equipment settings.

- N. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
1. Extra Filter Elements: One of each type, including fuel, oil and air.

1.6 QUALITY ASSURANCE

- A. Comply with the following:
1. NFPA 70 (National Electrical Code).
 2. NFPA 37 (Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines).
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
1. Authorized service facilities located within 200 miles of project site.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store generator sets in accordance with manufacturer's instructions and NECA/EGSA 404.
- B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- C. Handle carefully in accordance with manufacturer's instructions to avoid damage to generator set components, enclosure, and finish.

1.8 FIELD CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.9 WARRANTY

- A. Provide minimum two year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Packaged Engine Generator Set - Basis of Design: Kohler 250REZXB.
- B. Packaged Engine Generator Set - Other Acceptable Manufacturers:
1. Caterpillar Inc: www.cat.com.
 2. Cummins Power Generation Inc: www.cumminspower.com.
 3. Generac Power Systems: www.generac.com/industrial.
 4. MTU Onsite Energy, a Brand of Rolls-Royce Power Systems: www.mtuonsiteenergy.com.
- C. Products other than basis of design are subject to compliance with specified requirements and prior approval of Engineer. By using products other than basis of design, Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.

- D. Source Limitations: Furnish engine generator sets and associated components and accessories produced by a single manufacturer and obtained from a single supplier.

2.2 PACKAGED ENGINE GENERATOR SYSTEM

- A. Provide new engine generator system consisting of all required equipment, sensors, conduit, boxes, wiring, piping, supports, accessories, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. System Description:
1. Application: Emergency/standby.
 2. Configuration: Single packaged engine generator set operated independently (not in parallel).
- D. Packaged Engine Generator Set:
1. Type: Gaseous (spark ignition).
 2. Basis of Design: Kohler 250REZXB.
 3. Power Rating: As indicated on drawings, standby.
 4. Voltage: As indicated on drawings.
 5. Main Line Circuit Breaker:
 - a. Type: Electronic trip with long time and short time delay and instantaneous pickup.
 - b. Trip Rating: As indicated on drawings.
- E. Generator Set General Requirements:
1. Prototype tested in accordance with NFPA 110 for Level 1 systems.
 2. Factory-assembled, with components mounted on suitable base.
 3. List and label engine generator assembly as complying with UL 2200.
 4. Power Factor: Unless otherwise indicated, specified power ratings are at 0.8 power factor for three phase voltages and 1.0 power factor for single phase voltages.
 5. Provide suitable guards to protect personnel from accidental contact with rotating parts, hot piping, and other potential sources of injury.
 6. Main Line Circuit Breakers: Provide factory-installed line side connections with suitable lugs for load side connections.
- F. Service Conditions: Provide engine generator system and associated components suitable for operation under the service conditions at the installed location.
- G. Starting and Load Acceptance Requirements:
1. Cranking Method: Cycle cranking complying with NFPA 110 (15 second crank period, followed by 15 second rest period, with cranking limiter time-out after 3 cycles), unless otherwise required.
 2. Cranking Limiter Time-Out: If generator set fails to start after specified cranking period, indicate overcrank alarm condition and lock-out generator set from further cranking until manually reset.
 3. Start Time: Capable of starting and achieving conditions necessary for load acceptance within 10 seconds (NFPA 110, Type 10).
 4. Maximum Load Step: Supports 100 percent of rated load in one step.
- H. Exhaust Emissions Requirements:
1. Comply with federal (EPA), state, and local regulations applicable at the time of commissioning; include factory emissions certification with submittals.
 2. Do not make modifications affecting generator set factory emissions certification without approval of manufacturer and Engineer. Where such modifications are made, provide field emissions testing as necessary for certification.

I. Sound Level Requirements:

1. Do not exceed 80 dBA max. when measured at 23 feet from generator set in free field (no sound barriers) while operating at full load; include manufacturer's sound data with submittals.
2. Comply with applicable noise level regulations.

2.3 ENGINE AND ENGINE ACCESSORY EQUIPMENT

- A. Provide engine with adequate horsepower to achieve specified power output at rated speed, accounting for alternator efficiency and parasitic loads.
- B. Engine Fuel System - Gaseous (Spark Ignition):
 1. Fuel Source: Natural gas.
 2. Engine Fuel Connections: Provide suitable, approved flexible fuel lines for coupling engine to fuel source.
 3. Provide components/features indicated and as necessary for operation and/or required by applicable codes, including but not limited to:
 - a. Carburetor.
 - b. Gas pressure regulators.
 - c. Fuel shutoff control valves.
 - d. Low gas pressure switches.
- C. Engine Starting System:
 1. System Type: Electric, with DC solenoid-activated starting motor(s).
 2. Battery(s):
 - a. Battery Type: Lead-acid.
 - b. Battery Capacity: Size according to manufacturer's recommendations for achieving starting and load acceptance requirements under worst case ambient temperature; capable of providing cranking through two complete periods of cranking limiter time-outs without recharging.
 - c. Provide battery rack, cables, and connectors suitable for the supplied battery(s); size battery cables according to manufacturer's recommendations for cable length to be installed.
 3. Battery-Charging Alternator: Engine-driven, with integral solid-state voltage regulation.
 4. Battery Charger:
 - a. Provide dual rate battery charger with automatic float and equalize charging modes and minimum rating of 10 amps; suitable for maintaining the supplied battery(s) at full charge without manual intervention.
 - b. Capable of returning supplied battery(s) from fully discharged to fully charged condition within 24 hours, as required by NFPA 110 for Level 1 applications while carrying normal loads.
 - c. Recognized as complying with UL 1236.
 - d. Furnished with integral overcurrent protection; current limited to protect charger during engine cranking; reverse polarity protection.
 - e. Provide integral DC output ammeter and voltmeter with five percent accuracy.
 - f. Provide alarm output contacts as necessary for alarm indications.
 5. Battery Heater: Provide thermostatically controlled battery heater to improve starting under cold ambient conditions.
- D. Engine Speed Control System (Governor):
 1. Single Engine Generator Sets (Not Operated in Parallel): Provide electronic isochronous governor for controlling engine speed/alternator frequency.
 2. Frequency Regulation, Electronic Isochronous Governors: No change in frequency from no load to full load; plus/minus 0.25 percent at steady state.

E. Engine Lubrication System:

1. System Type: Full pressure, with engine-driven, positive displacement lubrication oil pump, replaceable full-flow oil filter(s), and dip-stick for oil level indication. Provide oil cooler where recommended by manufacturer.
2. Oil Heater: Provide thermostatically controlled oil heater to improve starting under cold ambient conditions.

F. Engine Cooling System:

1. System Type: Closed-loop, liquid-cooled, with unit-mounted radiator/fan and engine-driven coolant pump; suitable for providing adequate cooling while operating at full load under worst case ambient temperature.
2. Fan Guard: Provide suitable guard to protect personnel from accidental contact with fan.
3. Coolant Heater: Provide thermostatically controlled coolant heater to improve starting under cold ambient conditions; size according to manufacturer's recommendations for achieving starting and load acceptance requirements under worst case ambient temperature.

G. Engine Air Intake and Exhaust System:

1. Air Intake Filtration: Provide engine-mounted, replaceable, dry element filter.
2. Engine Exhaust Connection: Provide suitable, approved flexible connector for coupling engine to exhaust system.

2.4 ALTERNATOR (GENERATOR)

- A. Alternator: 4-pole, 1800 rpm (60 Hz output) revolving field, synchronous generator complying with NEMA MG 1; connected to engine with flexible coupling; voltage output configuration as indicated, with reconnectable leads for 3 phase alternators.
- B. Exciter:
1. Exciter Type: Brushless; provide permanent magnet generator (PMG) excitation system; self-excited (shunt) systems are not permitted.
 2. PMG Excitation Short-Circuit Current Support: Capable of sustaining 300 percent of rated output current for 10 seconds.
 3. Voltage Regulation (with PMG excitation): Plus/minus 0.5 percent for any constant load from no load to full load.
- C. Temperature Rise: Comply with UL 2200.
- D. Insulation System: NEMA MG 1, Class H; suitable for alternator temperature rise.
- E. Enclosure: NEMA MG 1, drip-proof.
- F. Total Harmonic Distortion: Not greater than five percent.
- G. Alternator Heater: Provide strip heater to prevent moisture condensation on alternator windings.

2.5 GENERATOR SET CONTROL SYSTEM

- A. Provide microprocessor-based control system for automatic control, monitoring, and protection of generator set. Include sensors, wiring, and connections necessary for functions/indications specified.
- B. Control Panel:
1. Control Panel Mounting: Unit-mounted unless otherwise indicated; vibration isolated.
 2. Generator Set Control Functions:
 - a. Automatic Mode: Initiates generator set start/shutdown upon receiving corresponding signal from remote device (e.g. automatic transfer switch).

- b. Manual Mode: Initiates generator set start/shutdown upon direction from operator.
 - c. Reset Mode: Clears all faults, allowing generator set restart after a shutdown.
 - d. Emergency Stop: Immediately shuts down generator set (without time delay) and prevents automatic restarting until manually reset.
 - e. Cycle Cranking: Programmable crank time, rest time, and number of cycles.
 - f. Time Delay: Programmable for shutdown (engine cooldown) and start (engine warmup).
 - g. Voltage Adjustment: Adjustable through range of plus/minus 5 percent.
- 3. Generator Set Status Indications:
 - a. Voltage (Volts AC): Line-to-line, line-to-neutral for each phase.
 - b. Current (Amps): For each phase.
 - c. Frequency (Hz).
 - d. Real power (W/kW).
 - e. Reactive power (VAR/kVAR).
 - f. Apparent power (VA/kVA).
 - g. Power factor.
 - h. Duty Level: Actual load as percentage of rated power.
 - i. Engine speed (RPM).
 - j. Battery voltage (Volts DC).
 - k. Engine oil pressure.
 - l. Engine coolant temperature.
 - m. Engine run time.
 - n. Generator powering load (position signal from transfer switch).
- 4. Generator Set Protection and Warning/Shutdown Indications:
 - a. Comply with NFPA 110; configurable for NFPA 110 Level 1 or Level 2, or NFPA 99 systems including but not limited to the following protections/indications:
 - 1) Overcrank (shutdown).
 - 2) Low coolant temperature (warning).
 - 3) High coolant temperature (warning).
 - 4) High coolant temperature (shutdown).
 - 5) Low oil pressure (shutdown).
 - 6) Overspeed (shutdown).
 - 7) Low fuel level (warning).
 - 8) Low coolant level (warning/shutdown).
 - 9) Generator control not in automatic mode (warning).
 - 10) High battery voltage (warning).
 - 11) Low cranking voltage (warning).
 - 12) Low battery voltage (warning).
 - 13) Battery charger failure (warning).
 - b. In addition to NFPA 110 requirements, provide the following protections/indications:
 - 1) High AC voltage (shutdown).
 - 2) Low AC voltage (shutdown).
 - 3) High frequency (shutdown).
 - 4) Low frequency (shutdown).
 - 5) Overcurrent (shutdown).
 - c. Provide contacts for local and remote common alarm.
 - d. Provide lamp test function that illuminates all indicator lamps.
- 5. Other Control Panel Features:
 - a. Event log.

C. Remote Annunciator:

1. Remote Annunciator Mounting: Wall-mounted; Provide flush-mounted annunciator for finished areas and surface-mounted annunciator for non-finished areas unless otherwise indicated.
2. Generator Set Status Indications:
 - a. Generator powering load (via position signal from transfer switch).
 - b. Communication functional.
3. Generator Set Warning/Shutdown Indications:
 - a. Comply with NFPA 110; configurable for NFPA 110 Level 1 or Level 2, or NFPA 99 systems including but not limited to the following indications:
 - 1) Overcrank (shutdown).
 - 2) Low coolant temperature (warning).
 - 3) High coolant temperature (warning).
 - 4) High coolant temperature (shutdown).
 - 5) Low oil pressure (shutdown).
 - 6) Overspeed (shutdown).
 - 7) Low fuel level (warning).
 - 8) Low coolant level (warning/shutdown).
 - 9) Generator control not in automatic mode (warning).
 - 10) High battery voltage (warning).
 - 11) Low cranking voltage (warning).
 - 12) Low battery voltage (warning).
 - 13) Battery charger failure (warning).
 - b. Provide audible alarm with silence function.
 - c. Provide lamp test function that illuminates all indicator lamps.
- D. Remote Emergency Stop: Provide approved red, mushroom style remote emergency stop button where indicated or required by authorities having jurisdiction. Provide tamper-proof, weather-proof cover to avoid accidental activation or tampering.

2.6 GENERATOR SET ENCLOSURE

- A. Enclosure Type: Sound attenuating, weather protective.
- B. Enclosure Material: Steel or aluminum.
- C. Hardware Material: Stainless steel.
- D. Color: Manufacturer's standard.
- E. Access Doors: Lockable, with all locks keyed alike.
- F. Openings: Designed to prevent bird/rodent entry.
- G. External Drains: Extend oil and coolant drain lines to exterior of enclosure for maintenance service.
- H. Sound Attenuating Enclosures: Line enclosure with non-hydroscopic, self-extinguishing sound-attenuating material.
- I. Exhaust Silencers: Where exhaust silencers are mounted within enclosure in main engine compartment, insulate silencer to minimize heat dissipation as necessary for operation at rated load under worst case ambient temperature.

2.7 SOURCE QUALITY CONTROL

- A. Perform production tests on generator sets at factory to verify operation and performance characteristics prior to shipment. Include certified test report with submittals.

- B. Generator Set production testing to include, at a minimum:
 - 1. Operation at rated load and rated power factor.
 - 2. Single step load pick-up.
 - 3. Transient and steady state voltage and frequency performance.
 - 4. Operation of safety shutdowns.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that the ratings and configurations of generator sets and auxiliary equipment are consistent with the indicated requirements.
- C. Verify that rough-ins for field connections are in the proper locations.
- D. Verify that mounting surfaces are ready to receive equipment.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship).
- B. Install products in accordance with manufacturer's instructions.
- C. Install generator sets and associated accessories in accordance with NECA/EGSA 404.
- D. Arrange equipment to provide minimum clearances and required maintenance access.
- E. Unless otherwise indicated, mount generator set on properly sized, minimum 6 inch high concrete pad constructed in accordance with Section 03 30 53. Follow detail on electrical drawings for construction of generator pad.
- F. Provide required support and attachment in accordance with Section 26 05 29.
- G. Use manufacturer's recommended oil and coolant, suitable for the worst case ambient temperatures.
- H. Provide grounding and bonding in accordance with Section 26 05 26.
- I. Identify system wiring and components in accordance with Section 26 05 53.

3.3 FIELD QUALITY CONTROL

- A. Provide services of a manufacturer's authorized representative to prepare and start systems and perform inspection and testing. Include manufacturer's detailed testing procedures and field reports with submittals.
- B. Notify Owner and Engineer at least two weeks prior to scheduled inspections and tests.
- C. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.
- D. Provide all equipment, tools, and supplies required to accomplish inspection and testing, including load bank and fuel.
- E. Preliminary inspection and testing to include, at a minimum:

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1. Inspect each system component for damage and defects.
 2. Verify tightness of mechanical and electrical connections are according to manufacturer's recommended torque settings.
 3. Check for proper oil and coolant levels.
- F. Prepare and start system in accordance with manufacturer's instructions.
- G. Perform acceptance test in accordance with NFPA 110.
- H. Inspection and testing to include, at a minimum:
1. Verify compliance with starting and load acceptance requirements.
 2. Verify voltage and frequency; make required adjustments as necessary.
 3. Verify phase sequence.
 4. Verify control system operation, including safety shutdowns.
 5. Verify operation of auxiliary equipment and accessories (e.g. battery charger, heaters, etc.).
 6. Perform load tests in accordance with NFPA 110 (1.5 hour building load test followed by 2 hour full load test).
- I. Provide field emissions testing where necessary for certification.
- J. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.
- K. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.4 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.5 CLOSEOUT ACTIVITIES

- A. Demonstration: Demonstrate proper operation of system to Owner, and correct deficiencies or make adjustments as directed.
- B. Training: Train Owner's personnel on operation, adjustment, and maintenance of system.
1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 2. Provide minimum of four hours of training.
 3. Instructor: Manufacturer's authorized representative.
 4. Location: At project site.
- C. After successful acceptance test and just prior to Substantial Completion, replace air, oil, and fuel filters.

3.6 PROTECTION

- A. Protect installed engine generator system from subsequent construction operations.

END OF SECTION 26 32 13

SECTION 26 36 00**TRANSFER SWITCHES****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Transfer switches for low-voltage (600 V and less) applications and associated accessories:
 - 1. Automatic transfer switches.

1.2 RELATED REQUIREMENTS

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- D. Section 26 32 13 - Engine Generators: For interface with transfer switches.
 - 1. Includes additional testing requirements.
 - 2. Includes related demonstration and training requirements.

1.3 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
- C. NEMA ICS 10 Part 1 - Industrial Control and Systems Part 1: Electromechanical AC Transfer Switch Equipment; 2005.
- D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2013.
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. NFPA 110 - Standard for Emergency and Standby Power Systems; 2013.
- G. UL 1008 - Transfer Switch Equipment; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate compatibility of transfer switches to be installed with work provided under other sections or by others.
 - a. Engine Generators: See Section 26 32 13.
 - 2. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.
 - 3. Coordinate arrangement of equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 4. Coordinate the work with placement of supports, anchors, etc. required for mounting.
 - 5. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

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- B. Preinstallation Meeting: Convene one week before starting work of this section; require attendance of all affected installers.
- C. Where work of this section involves interruption of existing electrical service, arrange service interruption with Owner.

1.5 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product, including ratings, configurations, dimensions, finishes, weights, service condition requirements, and installed features.
- B. Shop Drawings: Include dimensioned plan views and sections indicating locations of system components, required clearances, and field connection locations. Include system interconnection schematic diagrams showing all factory and field connections.
- C. Specimen Warranty: Submit sample of manufacturer's warranty.
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.
- E. Manufacturer's certification that products meet or exceed specified requirements.
- F. Source quality control test reports.
- G. Manufacturer's detailed field testing procedures.
- H. Field quality control test reports.
- I. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
- J. Executed Warranty: Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.
- K. Project Record Documents: Record actual locations of system components, installed circuiting arrangements and routing, and final equipment settings.

1.6 QUALITY ASSURANCE

- A. Comply with the following:
 - 1. NFPA 70 (National Electrical Code).
 - 2. NFPA 110 (Standard for Emergency and Standby Power Systems).
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
 - 1. Authorized service facilities located within 200 miles of project site.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

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1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store transfer switches in accordance with manufacturer's instructions.
- B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- C. Handle carefully in accordance with manufacturer's instructions to avoid damage to transfer switch components, enclosure, and finish.

1.8 FIELD CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.9 WARRANTY

- A. Provide minimum two year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS**2.1 MANUFACTURERS**

- A. Transfer Switches:
 - 1. Same as manufacturer of engine generator(s) used for this project.
- B. Products other than basis of design are subject to compliance with specified requirements and prior approval of Engineer. By using products other than basis of design, Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.
- C. Source Limitations: Furnish transfer switches and accessories produced by a single manufacturer and obtained from a single supplier.

2.2 TRANSFER SWITCHES

- A. Provide complete power transfer system consisting of all required equipment, conduit, boxes, wiring, supports, accessories, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Applications:
 - 1. Utilize open transition transfer unless otherwise indicated or required.
 - 2. Neutral Switching (Single Phase, Three Wire and Three Phase, Four Wire Systems):
 - a. Unless otherwise indicated or required, provide neutral switching:
 - 1) Where the alternate/emergency source is a separately derived system.
- D. Construction Type: Only "contactor type" (open contact) transfer switches are acceptable. Do not use "breaker type" (enclosed contact) transfer switches.
- E. Automatic Transfer Switch:
 - 1. Transfer Switch Type: Automatic transfer switch.
 - 2. Transition Configuration: Open-transition (no neutral position).
 - 3. Voltage: As indicated on the drawings.
 - 4. Ampere Rating: As indicated on the drawings.

5. Neutral Configuration: Switched neutral.
 6. Load Served: As indicated on the drawings.
 7. Primary Source: As indicated on the drawings.
 8. Alternate Source: As indicated on the drawings.
- F. Comply with NEMA ICS 10 Part 1, and list and label as complying with UL 1008 for the classification of the intended application (e.g. emergency, optional standby).
- G. Do not use double throw safety switches or other equipment not specifically designed for power transfer applications and listed as transfer switch equipment.
- H. Load Classification: Classified for total system load (any combination of motor, electric discharge lamp, resistive, and tungsten lamp loads with tungsten lamp loads not exceeding 30 percent of the continuous current rating) unless otherwise indicated or required.
- I. Switching Methods:
1. Open Transition:
 - a. Provide break-before-make transfer without a neutral position that is not connected to either source, and with interlocks to prevent simultaneous connection of the load to both sources.
 - b. Where in-phase transfer is indicated, utilize in-phase monitor to initiate transfer when phase angle difference between sources is near zero to limit in-rush currents.
 2. Delayed Transition:
 - a. Provide break-before-make transfer with programmable time delay in a neutral position not connected to either source, and with interlocks to prevent simultaneous connection of the load to both sources.
 3. Neutral Switching: Either simultaneously switched neutral (break-before-make) or overlapping neutral (make-before-break) methods are acceptable.
 4. Obtain control power for transfer operation from line side of source to which the load is to be transferred.
- J. Service Conditions: Provide transfer switches suitable for continuous operation at indicated ratings under the service conditions at the installed location.
- K. Enclosures:
1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1 or Type 12.
 2. Finish: Manufacturer's standard unless otherwise indicated.
- L. Short Circuit Current Rating:
1. Withstand and Closing Rating: Provide transfer switches, when protected by the supply side overcurrent protective devices to be installed, with listed withstand and closing rating not less than the available fault current at the installed location as indicated on the drawings.
- M. Automatic Transfer Switches:
1. Description: Transfer switches with automatically initiated transfer between sources; electrically operated and mechanically held.
 2. Control Functions:
 - a. Automatic mode.
 - b. Test Mode: Simulates failure of primary/normal source.
 - c. Voltage and Frequency Sensing:
 - 1) Undervoltage sensing for each phase of primary/normal source; adjustable dropout/pickup settings.

- 2) Undervoltage sensing for alternate/emergency source; adjustable dropout/pickup settings.
- 3) Underfrequency sensing for alternate/emergency source; adjustable dropout/pickup settings.
- d. Outputs:
 - 1) Contacts for engine start/shutdown (except where direct generator communication interface is provided).
 - 2) Auxiliary contacts; one set(s) for each switch position.
- e. Adjustable Time Delays:
 - 1) Engine generator start time delay; delays engine start signal to override momentary primary/normal source failures.
 - 2) Transfer to alternate/emergency source time delay.
 - 3) Retransfer to primary/normal source time delay.
 - 4) Engine generator cooldown time delay; delays engine shutdown following retransfer to primary/normal source to permit generator to run unloaded for cooldown period.
- f. In-Phase Monitor (Open Transition Transfer Switches): Monitors phase angle difference between sources for initiating in-phase transfer.
- g. Engine Exerciser: Provides programmable scheduled exercising of engine generator selectable with or without transfer to load; provides memory retention during power outage.
3. Status Indications:
 - a. Connected to alternate/emergency source.
 - b. Connected to primary/normal source.
 - c. Alternate/emergency source available.
4. Other Features:
 - a. Event log.
5. Automatic Sequence of Operations:
 - a. Upon failure of primary/normal source for a programmable time period (engine generator start time delay), initiate starting of engine generator where applicable.
 - b. When alternate/emergency source is available, transfer load to alternate/emergency source after programmable time delay.
 - c. When primary/normal source has been restored, retransfer to primary/normal source after a programmable time delay. Bypass time delay if alternate/emergency source fails and primary/normal source is available.
 - d. Where applicable, initiate shutdown of engine generator after programmable engine cooldown time delay.
- N. Interface with Other Work:
 1. Interface with engine generators as specified in Section 26 32 13.

2.3 SOURCE QUALITY CONTROL

- A. Perform production tests on transfer switches at factory to verify operation and performance characteristics prior to shipment. Include certified test report with submittals.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that the ratings and configurations of transfer switches are consistent with the indicated requirements.
- C. Verify that rough-ins for field connections are in the proper locations.

- D. Verify that mounting surfaces are ready to receive transfer switches.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship).
- B. Install products in accordance with manufacturer's instructions.
- C. Arrange equipment to provide minimum clearances and required maintenance access.
- D. Provide required support and attachment in accordance with Section 26 05 29.
- E. Install transfer switches plumb and level.
- F. Provide grounding and bonding in accordance with Section 26 05 26.
- G. Identify transfer switches and associated system wiring in accordance with Section 26 05 53.

3.3 FIELD QUALITY CONTROL

- A. Prepare and start system in accordance with manufacturer's instructions.
- B. Automatic Transfer Switches:
 - 1. Inspect and test in accordance with NETA ATS, except Section 4.
 - 2. Perform inspections and tests listed in NETA ATS, Section 7.22.3. The insulation-resistance tests listed as optional are not required.
- C. Provide additional inspection and testing as required for completion of associated engine generator testing as specified in Section 26 32 13.
- D. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.
- E. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.4 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.5 CLOSEOUT ACTIVITIES

- A. Demonstration: Demonstrate proper operation of transfer switches to Owner, and correct deficiencies or make adjustments as directed.
- B. Training: Train Owner's personnel on operation, adjustment, and maintenance of transfer switches.
 - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 - 2. Provide minimum of four hours of training.
 - 3. Instructor: Manufacturer's authorized representative.
 - 4. Location: At project site.
- C. Coordinate with related generator demonstration and training as specified in Section 26 32 13.

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3.6 PROTECTION

- A. Protect installed transfer switches from subsequent construction operations.

END OF SECTION 26 36 00

SECTION 26 43 00**SURGE PROTECTIVE DEVICES****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Surge protective devices for distribution locations.
- B. Surge protective devices for branch panelboard locations.

1.2 RELATED REQUIREMENTS

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

1.3 ABBREVIATIONS AND ACRONYMS

- A. EMI/RFI: Electromagnetic Interference/Radio Frequency Interference.
- B. SPD: Surge Protective Device.

1.4 REFERENCE STANDARDS

- A. MIL-STD-220 - Method of Insertion Loss Measurement; Revision C, 2009.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
- D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2013.
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. UL 1283 - Standard for Electromagnetic Interference Filters; Current Edition, Including All Revisions.
- G. UL 1449 - Standard for Surge Protective Devices; Current Edition, Including All Revisions.

1.5 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate size and location of overcurrent device compatible with the actual surge protective device and location to be installed. Notify Engineer of any conflicts or deviations from Contract Documents to obtain direction prior to ordering equipment.

1.6 SUBMITTALS

- A. Product Data: Include detailed component information, voltage, surge current ratings, repetitive surge current capacity, voltage protection rating (VPR) for all protection modes, maximum continuous operating voltage (MCOV), nominal discharge current (I-n), short circuit current rating (SCCR), connection means including any required external overcurrent protection, enclosure ratings, outline and support point dimensions, weight, service condition requirements, and installed features.
- B. Certificates: Manufacturer's documentation of listing for compliance with the following standards:
 - 1. UL 1449.
 - 2. UL 1283 (for Type 2 SPDs).
- C. Field Quality Control Test Reports.

- D. Manufacturer's Installation Instructions: Include application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- E. Operation and Maintenance Data: Include information on status indicators and recommended maintenance procedures and intervals.
- F. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.
- G. Project Record Documents: Record actual connections and locations of surge protective devices.

1.7 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.8 DELIVERY, STORAGE, AND PROTECTION

- A. Store in a clean, dry space in accordance with manufacturer's written instructions.

1.9 FIELD CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.10 WARRANTY

- A. Manufacturer's Warranty: Provide minimum five year warranty covering repair or replacement of surge protective devices showing evidence of failure due to defective materials or workmanship.
- B. Exclude surge protective devices from any clause limiting warranty responsibility for acts of nature, including lightning, stated elsewhere.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Field-installed, Externally Mounted Surge Protective Devices:
 - 1. Advanced Protection Technologies, Inc (APT): www.aptsurge.com.
 - 2. Current Technology; a brand of Thomas & Betts Power Solutions: www.tnbpowersolutions.com.
 - 3. Schneider Electric; Square D Brand Surgelogic Products: www.surgelogic.com.
- B. Products other than basis of design are subject to compliance with specified requirements and prior approval of Engineer. By using products other than basis of design, Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.
- C. Source Limitations: Furnish surge protective devices produced by a single manufacturer and obtained from a single supplier.

2.2 SURGE PROTECTIVE DEVICES - GENERAL REQUIREMENTS

- A. Description: Factory-assembled surge protective devices (SPDs) for 60 Hz service; listed, classified, and labeled as suitable for the purpose intended; system voltage as indicated on the drawings.
- B. Unless otherwise indicated, provide field-installed, externally-mounted or factory-installed, internally-mounted SPDs.
- C. List and label as complying with UL 1449, Type 1 when connected on line side of service disconnect overcurrent device and Type 1 or 2 when connected on load side of service disconnect overcurrent device.
- D. Protected Modes:
 - 1. Wye Systems: L-N, L-G, N-G, L-L.
- E. UL 1449 Voltage Protection Ratings (VPRs):
 - 1. 208Y/120V System Voltage: Not more than 1,000 V for L-N, L-G, and N-G modes and 1,200 V for L-L mode.
- F. UL 1449 Maximum Continuous Operating Voltage (MCOV): Not less than 115% of nominal system voltage.
- G. Enclosure Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - 1. Indoor clean, dry locations: Type 1.
- H. Mounting for Field-installed, Externally Mounted SPDs: Unless otherwise indicated, as specified for the following locations:
 - 1. Provide surface-mounted SPD where mounted in non-public areas or adjacent to surface-mounted equipment.

2.3 SURGE PROTECTIVE DEVICES FOR DISTRIBUTION LOCATIONS

- A. Distribution locations include SPDs connected to distribution panelboards.
- B. Surge Protective Device:
 - 1. Protection Circuits: Field-replaceable modular.
 - 2. Surge Current Rating: Not less than 80 kA per mode/160 kA per phase.
 - 3. UL 1449 Nominal Discharge Current (I-n): 20 kA.
 - 4. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.
 - 5. EMI/RFI Filtering: Provide EMI/RFI filter to attenuate electrical noise; listed as complying with UL 1283 for Type 2 SPDs (UL 1283 listing not available for Type 1 SPDs).
 - a. Noise Attenuation: Not less than 40 dB at 100 kHz using MIL-STD-220 insertion loss test method.
 - 6. Diagnostics:
 - a. Protection Status Monitoring: Provide indicator lights to report the protection status for each phase.
 - b. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.
 - c. Surge Counter: Provide surge event counter with manual reset button, surge count retention upon power loss, and six digit LCD display that indicates quantity of surge events.

2.4 SURGE PROTECTIVE DEVICES FOR BRANCH PANELBOARD LOCATIONS

- A. Surge Protective Device:
1. Protection Circuits: Field-replaceable modular.
 2. Surge Current Rating: Not less than 60 kA per mode/120 kA per phase.
 3. UL 1449 Nominal Discharge Current (I-n): 20 kA.
 4. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.
 5. EMI/RFI Filtering: Provide EMI/RFI filter to attenuate electrical noise; listed as complying with UL 1283 for Type 2 SPDs (UL 1283 listing not available for Type 1 SPDs).
 - a. Noise Attenuation: Not less than 40 dB at 100 kHz using MIL-STD-220 insertion loss test method.
 6. Diagnostics:
 - a. Protection Status Monitoring: Provide indicator lights to report the protection status for each phase.
 - b. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.
 - c. Surge Counter: Provide surge event counter with manual reset button, surge count retention upon power loss, and six digit LCD display that indicates quantity of surge events.

PART 3 EXECUTION**3.1 EXAMINATION**

- A. Verify that field measurements are as indicated.
- B. Verify that the service voltage and configuration marked on the SPD are consistent with the service voltage and configuration at the location to be installed.
- C. Verify system grounding and bonding is in accordance with Section 26 05 26, including bonding of neutral and ground for service entrance and separately derived systems where applicable. Do not energize SPD until deficiencies have been corrected.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship).
- B. Install products in accordance with manufacturer's instructions.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide conductors with minimum ampacity as indicated on the drawings, as required by NFPA 70, and not less than manufacturer's recommended minimum conductor size.
- E. Install conductors between SPD and equipment terminations as short and straight as possible, not exceeding manufacturer's recommended maximum conductor length. Breaker locations may be reasonably rearranged in order to provide leads as short and straight as possible. Twist conductors together to reduce inductance.
- F. Do not energize SPD until bonding of neutral and ground for service entrance and separately derived systems is complete in accordance with Section 26 05 26 where applicable. Replace SPDs damaged by improper or missing neutral-ground bond.

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- G. Disconnect SPD prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPD connected.

3.3 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS, except Section 4.
- B. Perform inspections and tests listed in NETA ATS Section 7.19.1.

3.4 CLEANING

- A. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 26 43 00

SECTION 31 23 17**TRENCHING, BACKFILLING, AND COMPACTING****PART 1 GENERAL****1.1 DESCRIPTION**

- A. The Work of This Section Includes, but is not limited to:
1. Trench excavation, backfill and compaction
 2. Support of excavation
 3. Electrical conduit/ductbank bedding requirements
 4. Control of excavated material
 5. Restoration of unpaved surfaces

1.2 QUALITY ASSURANCE

- A. Testing Agency: Density testing shall be performed by an independent soils testing laboratory engaged and paid for by the Contractor and approved by the Engineer.
- B. Referenced Standards:
1. Pennsylvania Department of Transportation (PADOT):
 - a. Publication 408 Specifications
 - b. Publication 213 Work Zone Traffic Control
 2. American Society for Testing and Materials (ASTM):
 - a. D698 - Test for Laboratory Compaction Characteristics of Soil Using Standard Effort
 - b. D1556 - Test for Density and Unit Weight of Soil in Place by the Sand Cone Method
 - c. D2922 - Test for Density of Soil and Soil Aggregate in Place by Nuclear Methods
- C. Density Testing:
1. Conduct a minimum of two tests per conduit/ductbank. Conduct one test in the lower half of the trench and one test in the upper half of the trench at locations as directed by the Engineer during backfilling operations. If any test fails, the Contractor shall take remedial steps to correct the compaction and rerun the test until compliance with the density requirements are shown. A density test that fails does not count toward the number of tests to be taken. The cost of the initial test and any required retesting is the responsibility of the Contractor.
 2. Determine density by ASTM D1556 or ASTM D2922.

1.3 SUBMITTALS

- A. Certificates:
1. Submit, prior to delivery of the material to the job site, a Statement of Compliance from the materials supplier, together with supporting data, attesting that the composition analysis of conduit/ductbank bedding and select material stone backfill materials meets specification requirements. Should a change in source of materials be made during construction, submit a new Statement of Compliance from the new source for approval before the material is delivered to the job site.
 2. Submit certified density testing results from the soils testing laboratory.
- B. Compaction Equipment List: Submit a list of all equipment to be utilized for compacting, including the equipment manufacturer's lift thickness limitations.
- C. Agreements with Property Owners: Prior to storing or disposing of excavated materials on private property, submit a copy of the written agreement with the property owner.

1.4 JOB CONDITIONS

- A. Classification of Excavation: All excavation, trenching, boring, jacking and tunneling work under this Contract shall be UNCLASSIFIED, and includes excavation and removal of all soil, rock, boulders, fill, and other materials encountered of whatever nature.
- B. Control of Traffic: Employ traffic control measures in accordance with Pennsylvania Department of Transportation Publication 213, "Work Zone Traffic Control".
- C. Protection of Existing Utilities and Structures:
 - 1. Take all precautions and utilize all facilities required to protect existing utilities and structures. In compliance with Act 121 of the General Assembly of Pennsylvania, PA One Call System and Common Grounds Alliance Best practices Manual, advise in advance of intent to excavate, do demolition work or use explosives and give the location of the job site. Request cooperative steps of the Utility and suggestions for procedures to avoid damage to its lines.
 - 2. Advise each person in physical control of powered equipment or explosives used in excavation or demolition work of the type and location of utility lines at the job site, the Utility assistance to expect, and procedures to follow to prevent damage.
 - 3. Immediately report to the Utility and the Engineer any break, leak or other damage to the lines or protective coatings made or discovered during the work and immediately alert the occupants of premises of any emergency created or discovered.
 - 4. Allow free access to Utility personnel at all times for purposes of maintenance, repair and inspection.

PART 2 PRODUCTS**2.1 CONDUIT/DUCTBANK BEDDING MATERIAL**

- A. Type IV Direct Buried Conduit Bedding Material: Screenings.

2.2 BACKFILL MATERIAL

- A. Coarse Aggregate Backfill: Crushed stone or gravel aggregate conforming to Subbase (2A), Section 703.2, Publication 408 Specifications.
- B. Suitable Backfill Material (Paved Areas):
 - 1. From top of conduit/ductbank bedding material to subgrade elevation:
 - a. Select Material Stone Backfill as specified in paragraph 2.2.A.
- C. Suitable Backfill Material (Non-Paved Areas):
 - 1. From top of conduit/ductbank bedding material to 24 inches over top of conduit/ductbank:
 - a. Material excavated from the trench if free of stones larger than 2 inches in size and free of wet, frozen, or organic materials.
 - 2. From 24 inches above conduit/ductbank to subgrade elevation:
 - a. Material excavated from the trench if free of stones larger than 8 inches in size and free of wet, frozen, or organic materials.
- D. Unsuitable Backfill Material: Where the Engineer deems backfill material to be unsuitable and rejects all or part thereof due to conditions prevailing at the time of construction, remove the unsuitable material and replace with select material stone backfill as specified in paragraph 2.2.A or suitable foreign backfill material.

PART 3 EXECUTION**3.1 MAINTENANCE AND PROTECTION OF TRAFFIC**

- A. Coordinate the work to ensure the least inconvenience to traffic and maintain traffic in one or more unobstructed lanes unless closing the street is authorized.
- B. Maintain access to all streets and private drives.
- C. Provide and maintain signs, flashing warning lights, barricades, markers, and other protective devices as required to conform with construction operations and to keep traffic flowing with minimum restrictions.
- D. Comply with State and local codes, permits and regulations.

3.2 CUTTING PAVED SURFACES

- A. Where excavation includes breaking a paved surface, make cuts in a neat uniform fashion forming straight lines parallel with the centerline of the trench. Cut offsets at right angles to the centerline of the trench. Saw cut concrete surfaces; saw cut other hard surfaces or make straight cuts with jackhammer. No paving shall be broken except that which has been previously cut.
- B. Protect edges of cut pavement during excavation to prevent raveling or breaking; square edges prior to pavement replacement.

3.3 BLASTING

- A. No blasting will be permitted.

3.4 TRENCH EXCAVATION

- A. Topsoil Stripping and Stockpiling: Strip topsoil encountered during trench excavation to its full depth and stockpile for reuse.
- B. Depth of Excavation:
 - 1. Electrical Conduits/Ductbanks:
 - a. Excavate trenches to the depth required for the direct buried conduit being installed plus the excavation necessary for the placement of the bedding material.
 - b. Where unsuitable bearing material is encountered in the trench bottom, continue excavation until the unsuitable material is removed, solid bearing is obtained or can be established, or concrete cradle can be placed. If no concrete cradle is to be installed, refill the trench to required grade with bedding material. This work will be handled by Change Order.
 - c. Where the Contractor, by error or intent, excavates beyond the minimum required depth, backfill the trench to the required grade with bedding material at no cost to the Owner.
 - d. No bedding is required for reinforced concrete encasement duct banks in areas of undisturbed soil or recompacted soil in accordance with these specifications.
- C. Width of Excavation:
 - 1. Excavate trenches to a width necessary for placing and jointing the conduit/ductbank and for placing and compacting bedding and backfill around the conduit/ductbank.
 - 2. Shape trench walls completely vertical from trench bottom to at least 24 inches above the top of the conduit/ductbank.
 - 3. Where rock is encountered in the sides of the trench, remove the rock to provide a minimum clearance between the conduit/ductbank and rock of 6 inches.

3.5 SUPPORT OF EXCAVATION

- A. Support excavations with sheeting, shoring, and bracing or a "trench box" as required to comply with Federal and State laws and codes. Install adequate excavation supports to prevent ground movement or settlement to adjacent structures, pipelines or utilities. Damage due to settlement because of failure to provide support or through negligence or fault of the Contractor in any other manner shall be repaired at the Contractor's expense.
- B. Withdraw shoring, bracing, and sheeting as backfilling proceeds unless otherwise directed by the Engineer.

3.6 CONTROL OF EXCAVATED MATERIAL

- A. Keep the ground surface within a minimum of 2 feet of both sides of the excavation free of excavated material.
- B. In areas where pipelines parallel or cross streams, ensure that no material slides, is washed, or dumped into the stream course. Remove cofferdams immediately upon completion of pipeline construction.
- C. Maintain accessibility to all fire hydrants, valve pit covers, valve boxes, curb boxes, fire and police call boxes, and other utility controls at all times. Keep gutters clear or provide other satisfactory facilities for street drainage. Do not obstruct natural watercourses. Where necessary, provide temporary channels to allow the flow of water either along or across the site of the work.
- D. Provide temporary barricades to prevent excavated material from encroaching on private property, walks, gutters, and storm drains.
- E. Do not place or store excavated material on private property without a written agreement signed by the property owner.

3.7 DEWATERING

- A. Keep excavations dry and free of water. Dispose of precipitation and subsurface water clear of the work.
- B. Maintain conduit/ductbank trenches dry until conduit/ductbank has been jointed, inspected, and backfilled, and concrete work has been completed. Prevent trench water from entering pipelines under construction.
- C. Intercept and divert surface drainage away from excavations. Maintain storm drainage facilities, gutters, and natural surface watercourses open and in operation. Provide and install temporary facilities to maintain excavations free of water as required. Design surface drainage systems so that they do not cause erosion on or off the site, or cause unwanted flow of water. When mechanical equipment is utilized to control water conditions, provide and maintain sufficient standby units onsite.
- D. Comply with Federal, State and Local requirements for dewatering to any watercourse, prevention of stream degradation, and erosion and sediment control. Comply with the Sedimentation and Erosion Control Plan.

3.8 CONDUIT/DUCTBANK BEDDING REQUIREMENTS

- A. Type IV Bedding:
 - 1. Depth of bedding material aggregate as shown on the Contract Drawings.
- B. Shape recesses for the joints or bell of the pipe by hand. Assure that the pipe is supported on the lower quadrant for the entire length of the barrel.

3.9 CONDUIT/DUCTBANK LAYING

- A. Lay conduit/ductbank as specified in the appropriate Section of these Specifications for conduit/ductbank construction.

3.10 BACKFILLING TRENCHES

- A. After conduit/ductbank installation and inspection, backfill trenches from trench bottom or from the top of conduit/ductbank bedding material, whichever is greater, to 12 inches above the crown of the conduit/ductbank with specified backfill material hand placed and carefully compacted with hand-operated mechanical tampers in layers of suitable thickness to provide specified density around and under the haunches of the conduit/ductbank. Backfill and compact the remainder of the trench with specified backfill material.
- B. Exposed Joints for Testing:
1. The Contractor has the option to test the pipe prior to backfilling the trench. If this option is selected, install reaction blocks where required and place 2 feet of thoroughly compacted backfill over the pipe leaving pipe joints partially exposed.
 2. If the Contractor elects to completely backfill the trench prior to testing, he shall be responsible for locating and uncovering leaks which may cause the test to fail.
- C. Lift Thickness Limitations:
1. In no case shall maximum lift thickness placed exceed the maximum limits specified by the manufacturer's recommendations. However, if the equipment manufacturer's lift thickness recommendation is followed and the specified density is not obtained, the Contractor shall, at his own expense, remove, replace, and retest as many times as is required to obtain the specified density.
 2. Compact each layer of backfill to 95 percent of the standard proctor maximum dry density as determined by ASTM D698 in load bearing areas and 90 percent in non-load bearing areas.
 3. Lift thickness limitations specified for state highways, shoulders, or embankments govern over the compaction equipment manufacturer's recommendations.
 4. Notwithstanding the specified requirements for trench backfill compaction, trenches that settle below the surrounding grade prior to final completion shall be filled to surrounding grade level with appropriate materials.

3.11 DISPOSAL OF EXCAVATED MATERIAL

- A. Excavated material remaining after completion of backfilling shall remain the property of the Contractor, removed from the construction area and legally disposed.

3.12 RESTORATION OF UNPAVED SURFACES

- A. Restore unpaved surfaces disturbed by construction to equal the surface condition prior to construction.

END OF SECTION 31 23 17

SECTION 32 31 13.10**CHAIN-LINK FENCES AND GATES****PART 1 GENERAL****1.1 DESCRIPTION**

- A. The Work of This Section Includes, but is not limited to:
 - 1. Chain-Link Fencing; 8-foot high
 - 2. Zinc-coated (Galvanized) steel fabric
 - a. Top rail, bottom tension wire
 - b. Three strands of barbed wire
 - c. Gates: Size and swing as indicated on the Contract Drawings

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Society for Testing and Materials (ASTM):
 - a. A120 Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless
 - b. A121 Zinc-Coated (Galvanized) Steel Barbed Wire
 - c. A123 Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip
 - d. A392 Zinc-Coated Steel Chain-Link Fence Fabric

1.3 SUBMITTALS

- A. Manufacturer's Product Data: Submit manufacturer's latest publications of descriptive literature and product data.
- B. Shop Drawings: Submit shop drawings of fence layout including details of gates, fittings, hardware, and anchoring.
- C. Compliance Statement: Submit a Statement of Compliance from the materials supplier(s), together with supporting data, attesting that the products provided meet or exceed specification requirements.

PART 2 PRODUCTS**2.1 CHAIN-LINK FABRIC**

- A. Zinc-Coated (Galvanized) Steel; ASTM A392, Class 1. Hot-dip galvanized after weaving. One-piece full height of fabric.
- B. 2 Inch Diamond Mesh; 9 gage (0.148 inches) wire, 1290 pound-feet minimum breaking strength
- C. Selvages:
 - 1. Selvages barbed and barbed

2.2 FRAMEWORK

- A. Galvanized Steel Pipe; ASTM A120, Schedule 40. Hot-dip galvanized inside and outside. Provide post caps.
- B. Fence Posts:
 - 1. Corner, Terminal and Pull Posts: 2.875" O.D.
 - 2. Line Posts: 2.375" O.D.
 - 3. Top Rail, Brace Rails: 1.660" O.D.

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4. Truss Rods: 0.313" Rod, w/Turnbuckles

C. Gate Posts:

<u>Single Gate</u>	<u>Double Gate</u>	<u>Post Size</u>
Up to 6 feet	Up to 12 feet	2.875 Inches O.D.
7 to 12 feet	13 to 25 feet	4 Inches O.D.
13 to 17 feet	26 to 35 feet	6.625 Inches O.D.

2.3 GATES

A. Framework:

- 1.66 inches O.D. galvanized steel pipe, with diagonal truss rods. Provide horizontal center rail on gates over 6 feet high; vertical center upright on gate leaves over 8 feet wide.

B. Hinges: Non-lift-off, 180 degree swing offset type, of size to accommodate gate frame and post.

2.4 FITTINGS

A. Rail ends, rail sleeves, tension bars, brace ends, post tops and caps, latch forks, lock keepers, and other appurtenances, including gate hinges and barbed wire support arms:

- Malleable, pressed or cast steel. Hot-dip galvanized after fabrication, ASTM A123.

2.5 TENSION WIRE

A. #6 gage Galvanized Coil Spring Tension Wire; #9 gage Hog Rings and Tie Wire.

2.6 BARBED WIRE

A. Double-Strand, Twisted, #12.5 gage Galvanized Steel Wire; ASTM A121 Class 3. #14 gage round 4-point barbs spaced 5" apart.

B. Barbed Wire Support Arms:

- Carry three parallel strands of barbed wire at 45 degree angle, the topmost strand approximately 12 inches from the fence line, on the side away from the enclosure.
- Capable of withstanding a 200 pound load applied vertically where the outer strand of barbed wire passes over the arm.

PART 3 EXECUTION

3.1 INSPECTION

- A. Verify that final grading in fence location is completed without irregularities which would interfere with fence installation. Do not commence work until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Measure and layout complete fence line; measure parallel to surface of ground.

- B. Locate and mark position of posts. Locate corner posts at each horizontal angle point; locate line posts at equal distant spacing on not more than 10 feet nor less than 8 feet centers, unless otherwise indicated on the Contract Drawings.

3.3 POST INSTALLATION

- A. Encase posts in concrete to minimum 3 feet depth. Extend concrete at least 6 inches below bottom of posts.
 - 1. 10 inches diameter encasement for line posts,
 - 2. 12 inches diameter encasement for end, corner, pull, and gate posts.
 - 3. Extend concrete 2 inches above finished grade, crowned to drain water away from the posts.
- B. Provide corner, end, and pull posts with a horizontal brace and tie rod on each side of the posts, extending and connecting to adjacent line posts.

3.4 FABRIC INSTALLATION

- A. Remove slack from fabric by means of mechanical fence stretchers before making attachment to posts.
- B. Cut fabric to form one continuous piece between terminal posts.
- C. Hold bottom of fabric 1 to 2 inches above finished grade.
- D. Attach fabric to terminal posts with vertical tension bars threaded through fabric and held by tension bands spaced maximum 12 inches off center.
- E. Fasten fabric to line posts with #9 gage ties, or by integral fabric lock loops as applicable, at maximum 12 inch intervals.
- F. Fasten fabric to top rail and intermediate rail with #9 gage ties at maximum 18 inch intervals.
- G. Fasten fabric to tension wire with hog rings and ties at maximum 18 inch intervals.

3.5 GATES

- A. Install gates of the size and swing as indicated on the Contract Drawings.
- B. Fill gate frame with same fabric as fence.
- C. Attach fabric to gate frame vertical end members with tension bars threaded through fabric and held by tension bands spaced maximum 12 inch intervals; attach to horizontal rails, center upright, and brace rails with #9 gage ties at maximum 12 inch intervals.
- D. Fasten barbed wire to gate frame upright extensions.
- E. Provide latch forks, lock keepers, catches, plungerbars and stop holders. Latches and plungerbars operable from either side of gate. Padlock hasp integral part of latch.
- F. Locate gate stops, set in concrete, so that plungerbar fully engages. Adjust hardware to provide smooth operation.

3.6 FIELD QUALITY CONTROL

- A. Remove and replace fencing which is improperly located or is not true to line and grade, and posts which are not plumb.
- B. Adjust brace rails and tension rods for rigid installation.
- C. Tighten hardware, fasteners and accessories.

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- D. Remove excess and waste materials from the project site.

END OF SECTION 32 31 13.10



445 West Philadelphia Street
York, PA 17401
(717) 852-1400
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